OCTOBER 1958

Power Engineering

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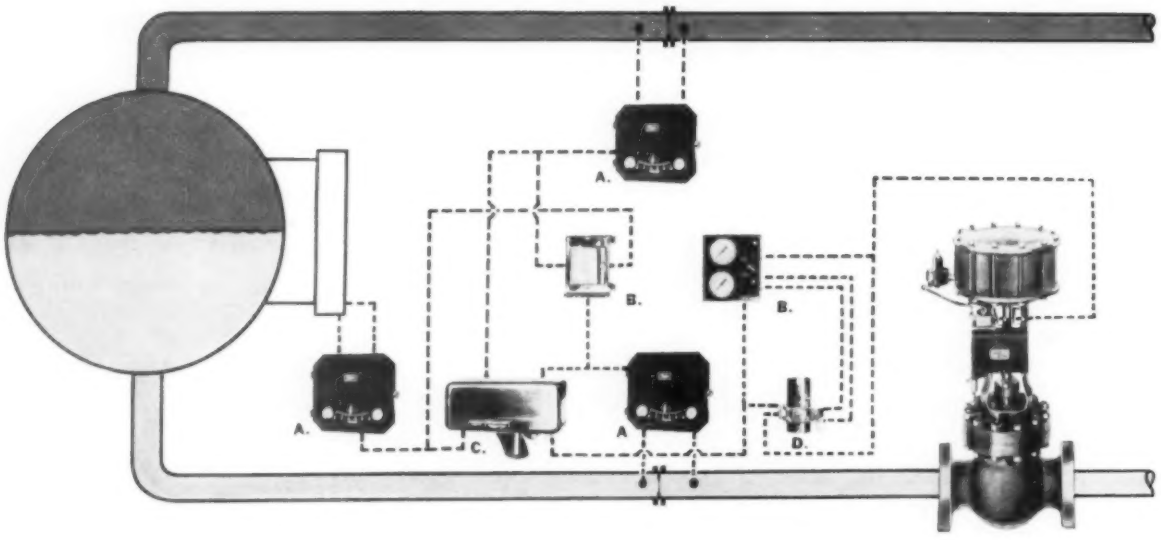
How Copes-Vulcan control systems boost power plant efficiency



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Feed to the boiler is modulated by steam flow, feedwater flow and drum water level. Feedwater input closely matches steam output on constant or varying loads. A stabilized water level is maintained regardless of changes in load or feed pressure, and while blowing down or blowing soot.

A complete line . . . a complete service

Over 50 years of design experience backs Copes-Vulcan's broad line of control systems for boiler cleaning, combustion, feedwater, pressure reducing and desuperheating operations.

For details, write for Bulletin 1013-D

A. Indicating transmitters send water level and flow influences to the computing relay where steam-flow and water-flow are accurately balanced.

B. Miniature recorders and transfer panel for console-type or graphic panels or for compact grouping on existing panels.

C. Compact beam-balanced type computing relay sends an air impulse to the controller and auto-manual transfer panel.

D. Transet controller provides two-knob tuning. Controller, transmitters and relays may be field mounted wherever most convenient.

E. Copes-Vulcan Type CV-P valve responds to minute changes in actuating impulse, delivers top power at the valve stem. For less demanding service Copes-Vulcan builds a diaphragm operated valve.

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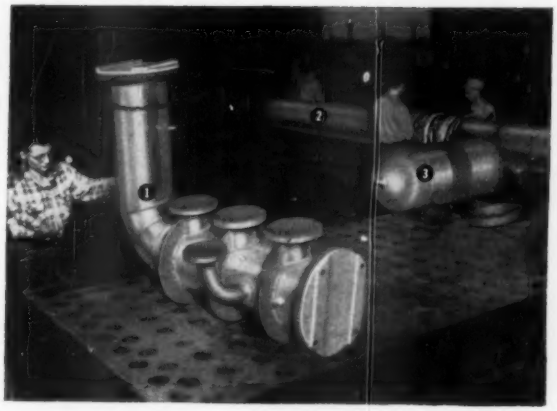
ALL IN A DAY'S WORK at *Pittsburgh Piping*



These three jobs are typical of the wide variety of custom piping work which we do for the power and process industries. In the background of the photo welders are shown making the heli-arc root pass on 18" O.D., 3.875" wall, chrome-moly main steam piping. In the foreground, ready for final inspection, is a 12" header for a process operation, fabricated of ⅜" aluminum alloy. The pressure vessel, of austenitic steel, is one of many we produce for atomic energy application. The manufacturing of this type of piping requires specialized facilities . . . for engineering, fabricating, testing, assembly, and erection. We have those facilities. Use them on your piping jobs.

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PURIFICATION OF CONDENSATE WITHIN THE CYCLE

THE MODERN METHOD OF:

- Increasing steam purity
- Increasing thermal efficiency
- Eliminating dissolved and suspended solids within the cycle
- Reducing the number of outages

As every power engineer knows, boiler and turbine outage is one of the most expensive operating costs for high pressure power plants in central stations. A major cause of shutdown -- as well as of reduced thermal efficiency -- is contamination of condensate and steam within the boiler-turbine cycle from such sources of solids as condenser leakage, fly ash, pre-boiler metallic corrosion and makeup solids.

Now...Internal Self-Purification of Condensate by Graver's "Kidney" Scavenging System can eliminate virtually all contamination within the cycle! This system consists of a high rate filter-mixed-bed demineralizer-filter combination that purifies condensate to parts per billion, instead of the usual parts per million...prevents build-up of corrosive products in the boiler and turbine cycles...considerably increases steam purity and, thereby, over-all cycle thermal efficiency. Thus, outages due to contamination can be eliminated and the need for blowdown, turbine washing and general all-around maintenance can be greatly reduced.

The "Kidney" also protects the cycle in case of condenser solids leakage through weepage or tube rupture. It continues to send a pure flow of feedwater to the steam generators -- giving the operating engineer adequate time to plan for an orderly shutdown without the usual confusion and excitement in case of tube rupture. With suitable selection of scavenging unit flow rates and bypass condensate flow rates, plus proper design of filters and mixed-bed demineralizers, the investment and operating cost for this treatment is quite economical.

Graver, a pioneer in the design of advanced water treatment equipment for the power industry, has devoted a large part of its chemical research and engineering development program to the "Kidney" Scavenging System. Designs are available to fit into every power cycle or plant arrangement. Whether you seek to improve thermal efficiency and reduce the number of outages at an existing station, or to build top efficiency into a new plant, write Graver for all the facts on High Rate Internal Self-Purification of Condensate by the "Kidney" Scavenging System!

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

SIX LEADERS in engineering education have led off in Michigan State University's search for a new concept on which to establish a branch university to be opened in 1959. MSU is trying to scrap precedent and tradition and start fresh. Groups of educators in various fields are being asked how they would set up a university if they were starting from scratch and had the money needed.

The six engineers who tackled this question in MSU's behalf included: Eric A. Walker, president of Penn State; C. Richard Soderberg, dean of engineering at MIT; Lee A. Du Bridge, president of Cal Tech; Newman Hall, chairman of mechanical engineering at Yale; Frederick E. Terman, dean of engineering at Stanford; and John D. Ryder, dean of engineering at Michigan State.

They all agreed that an engineering curriculum should shift emphasis from specialization to an overlapping into the sciences, as the only way to keep up with developments in the field.

They also felt that engineering schools of the future would make more of the top talent in each class. From this elite will come what is called "the innovator."

SUMMER'S NOW WINTER — in peak demand for electricity in the New York Metropolitan area. Consolidated Edison Co reports that between 3 and 4 p.m. of July 16, customers used a record 3,475,000 kw, and the company produced the largest 24-hr output in its history — 60,513,600 kwh.

Last year's peak occurred on June 26, with 3,460,000 kw used between 10:30 A.M. and 11:30 A.M.

Historically, peak demand has always been reached in late afternoon of a cold, dark and wet shopping day in winter. This peak was 3,241,000 kw in 1956.

Main reasons for this shift in peak demand from winter to summer are the rapid growth in the use of air conditioners, increase in the use of various refrigeration devices, TV and other applicances. ConEd estimates that air conditioning is now requiring more than 850,000 kw, or nearly one-fourth the company's 3,700,000-kw capacity.

ConEd has seen the change coming, for ten years has been building new facilities. A five-year program ending in 1961 will cost around $650,000,000, will add 350,000 kw a year to capacity through 1961, except for 275,000 kw in 1960. The company's capacity in 1947 was 2,456,000 kw.

MORE THAN 200 manufacturers have contracted for space in the 23rd National Exposition of Power and Mechanical Engineering to be held in the New York Coliseum, Dec. 1–5. The display will be staged under the auspices of ASME, whose 78th annual meeting occurs concurrently.

Featured this year will be a number of exhibits of heavy equipment built to customer specifications. One is a giant feedwater heater made in California for a power plant in New England, weighing 36,000 lb. Another innovation will be the first packaged water tube boiler seen at a power show.

Joseph Pope is chairman of the Advisory Committee for the Exposition, and John H. Lawrence is vice chairman. Committee members include: Cecil Boling, president, American Society of Refrigeration Engineers; F. L. Bradley, consultant, Stone & Webster; Chester R. Earle, editor of POWER ENGINEERING; M. J. Goblia, School of Mechanical Engineering, Georgia Institute of Technology; Kilshaw M. Irwin, vice president in charge of engineering, Philadelphia Electric Co; C. E. Morrow, assistant superintendent of construction, Western Electric Co; George A. Orrok, Boston Edison Co; E. R. Queer, president, American Society of Heating and Air-Conditioning Engineers; L. N. Rowley, editor of *Power;* C. J. Sibler, chief engineer, West Virginia Pulp & Paper Co; J. F. Downie Smith, vice president, research and

development, Carrier Corp; and A. Bowman Snavely, chief engineer, Hershey Chocolate Corp.

ASME representatives on the Advisory Committee include J. N. Landis, president; H. R. C. Carlson, The Carlson Co; E. W. Jacobson, chief design engineer, Gulf Research & Development Co; R. B. Smith, vice president, The M. W. Kellogg Co; G. B. Warren, Turbine Div, General Electric Co. All of these men are members of the Board of Technology. Also included is T. F. Perkinson, chairman of the Board; G. R. Fryling, chairman, Meetings Committee; and O. B. Schier, II, secretary of ASME.

DEAN of American engineers, Dr. William Frederick Durand, died August 9 after a brief illness. He was 99 years old. A pioneer in the field of aviation, Dr. Durand was editor of and contributor to the 6-vol definitive work, Aerodynamic Theory. During World War II he organized the American effort to design and produce jet engines. Dr. Durand served as president of ASME in 1924 and was an Honorary Member of the Society. He had served at various times on the faculties of Cornell University, Michigan State College and Stanford University, and had performed distinguished service for the U. S. government. He was awarded the John Fritz Medal in 1935, and was the first recipient of the Wright Brothers Memorial Trophy, awarded by the NAA.

NEW TRADEMARK for Worthington Corp, adopted Sept 24, is part of a far-reaching program of change now going on within the 118-year-old company. Under this program, Worthington will be decentralized to function as if it were a federation of smaller, independent companies. Each company will report to top management through a group vice-president. These group vice-presidents, together with the vice-presidents for marketing, engineering, manufacturing, and so on, will comprise president Walter H. Feldmann's staff.

It is felt that this approach to corporate organization will strengthen the "gear-to-the-customer" philosophy which is to be Worthington's new marketing concept.

40 YEARS of distinguished service have won for Dr. Charles F. Wagner the Westinghouse Service Pin. Internationally known as an authority on power transmission and lightning protection, Dr. Wagner began his career with Westinghouse in

Charles F. Wagner (left) receives Westinghouse Service Pin from Tomlinson Fort

1918, working at first with Joseph Slepian in research engineering. He has attained the prolific average of one patent a year since the start of his career. In 1951, he was awarded the Thomas A. Edison Medal.

NATIONAL METAL SHOW is being held in Cleveland this month from the 27th to the 31st in the Public Auditorium. Sponsoring body is the American Society for Metals, which is having its annual meeting concurrently at the Hotel Cleveland and the Statler-Hilton. Seven other related groups are holding sessions in Cleveland during these same days. These are: the Metallurgical Society of the American Institute of Mining, Metallurgical & Petroleum Engineers; two Divisions of AIME; Society for Nondestructive Testing; Industrial Heating Equipment Assn; Metal Powder Industries Federation; Metals Div of the Special Libraries Assn.

INCOME levels and employment characteristics of engineers, based on 1956 earnings, have been carefully analyzed by the National Society of Professional Engineers, which has 40,000 members. Summary report is now available at $1 a copy to non-NSPE members, 50 cents to members, from 2029 K St, NW, Washington 6, D. C.

Earnings for NSPE members in 1956 were at an all-time high, the study shows, with $9490 as the median figure for the group. Ninety per cent earned at least $6390; 75 per cent earned at least $7510; 25 per cent earned at least $12,840; 10 per cent earned at least $18,860.

Chemical engineers report consistently higher earnings than men in other branches. Civil engineers as a group are the lowest paid, the report finds. In all other branches, the median income for men with more than 20 years of experience in 1956 was usually in excess of $10,000.

This is NSPE's third biennial national salary survey. When the survey of 1952 was made, the median earnings of NSPE members was reported at $7850. For most groups of engineers, incomes increased more between 1954 and 1956 than they did between 1952 and 1954. The younger engineers experienced the greatest income gains, both percentagewise and in terms of dollar increases.

NEW STANDARDS from ASME are: Slotted and Recessed Head Tapping Screws and Metallic Drive Screws (ASA B18.6.4-1958), at $4 a copy; and Safety Standards for Compressor Systems, a proposed American Standard revision, a free copy of which may be had from D. M. Shackelford, for criticism and comment. Address all requests on letterhead, to ASME at 29 W 39th St, New York 18.

From Pipe Fabrication Institute comes Recommended Practices for Stress Relieving Welded Attachments. Free copy may be obtained from the Institute at One Gateway Center, Pittsburgh 22, Penna.

PLACE OF PLASTICS in industry seems to grow ever more important in a time of inflated production costs. The plastics industry is putting its best competitive foot forward in the 8th National Plastics Exposition and Conference, to be held in Chicago's International Amphitheatre and Hotel Morrison, November 17–21. Sponsor is the Society of the Plastics Industry.

In addition to stressing the technical and competitive advantages of plastics from a manufacturing standpoint, most of the 200 exhibitors will demonstrate the progress of research and development programs during the past two years.

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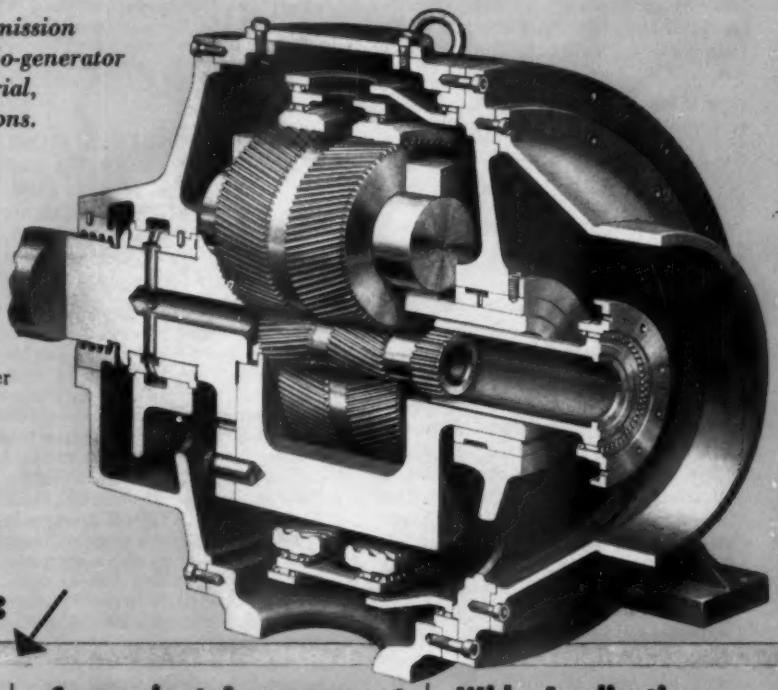
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

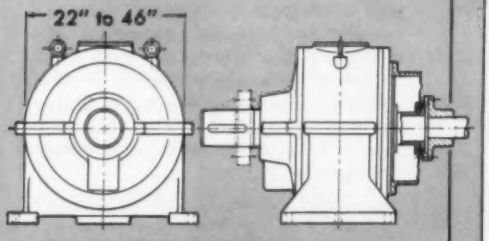
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.



Check These Advantages:

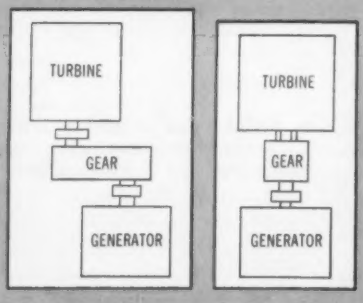
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



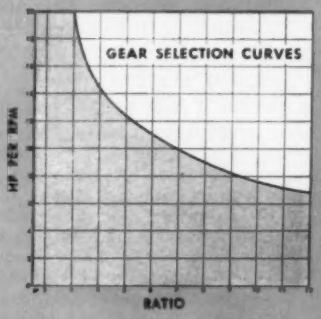
Convenient Arrangement

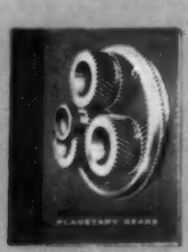
Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.





For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

816 Nottingham Way, Trenton 2, New Jersey

DL481

WHAT THEY TELL US

▶ **WRITING** in the July issue (pages 54–57), Bill Richard of General Cable Corp described the nature of mineral-insulated cable and its versatile use in electrical systems. Now the company tells us that the material used with special Type H explosion-proof fittings has been approved for use in hazardous locations. Interim amendment of the National Electrical Code has brought this about. The company writes:

> This supplements and extends 1953 recognition of this same cable with Type O terminations for general use at a continuous operating temperature of 185 F; 482 F in special applications. Because of the prevalence of low flash point solvents and vapors in many industrial applications classified as hazardous, the latest approval contemplates a maximum operating temperature of 185 F (85 C).

▶ **DO YOU USE** an incentive plan in working with power plant supervisors, at any level? Various engineers have asked us about the incentive idea as applied to power plant supervision. At this writing, we do not know of any incentive plan which is being used successfully in power plant work. If you are operating such a plan, please write us. Your experience will help others — and thanks.

▶ **WILL REINJECTION** of fly ash improve power plant efficiency? This question is being debated in these columns by A. H. Gesell, utilities engineer at the Central Generating Station in Waupun, Wis., and M. J. Churchill of Detroit Stoker. Gesell says no (July issue); Churchill says yes (September issue). This month it's Gesell's turn for another shot:

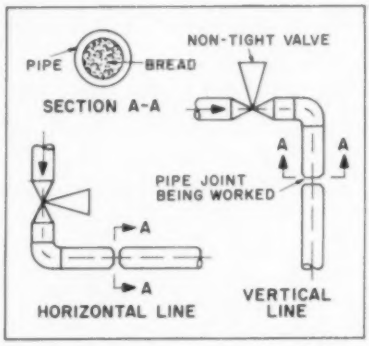
> We have identical boilers and the fly ash reinjection tests were made on these. The boilers are Wickes 4-drum with water walls, 4300 sq ft heating surface, water walls 830 sq ft, furnace volume 1650 cu ft, steam pressure 450 lb, 650 F.
>
> We will again be testing one boiler against the other this winter, and then I will mail you all these data. As soon as we are testing, I hope Mr. Churchill can find time to visit us here at Waupun, and we will let him do the testing himself. There are no strings tied to this proposition, and he can do anything he likes to prove his point.
>
> We feel that with air reinjection any benefit obtained is offset by the excess secondary air. The fly carbon did not burn the first time through, so how are you going to burn it the second time through? There is a slight benefit at 200 to 250 per cent rating; but where do you find a plant that can operate at such ratings continually over a 24-hour period?

▶ **WHAT INTERESTS YOU MOST** in POWER ENGINEERING? We naturally like to ask this question whenever we can, to check editorial sights and test readership. This answer, from Reader V. A. C., engineer in a Missouri college, was based on his reading of the June issue:

> To say what interests me most would be like trying to pick out the food I like best in a square meal. This is the way I feel about POWER ENGINEERING.
>
> You have several good articles that interest me very much. For instance, you have an article entitled, H_2D_2 as Fuel in Fusion Power, by Yasha Yavitch. This ATOMICS series interests me very much since my recent visit to Los Alamos and a conducted tour through the new Van de Graaff and the two new power reactors. However, we cannot dismiss the fact that the article, Air-Source Heat Pumps Prove Practical and Economical, is a very timely and good article. Of course, good articles appear in your magazine quite often. In fact, I have never read a dull article in POWER ENGINEERING.
>
> I will say what the farmer said to his son while teaching him how to feed stock. He said, "Son, feed them mixed food."
>
> That is the way POWER ENGINEERING appeals to me.

▶ **BREAD** can be used as a packing to prevent drainage when work is being done on a low pressure pipe joint. So H. B. Wayne, of Woodhaven, N. Y., tells us (though he doesn't say whether it should be white or rye):

> Although a valve may be installed, non-tight seating frequently prevails, preventing complete shut-off. Also, if a horizontal line is being worked on, full drainage is difficult to obtain because residual fluid tends to remain in the pipe. As operations are carried on, vibration and pipe movement drain the liquid, thereby interfering with operations such as soldering, brazing, etc.
>
> One method of overcoming these difficulties is to pack the pipe with bread. The liquid causes the bread to swell, preventing flow past the joint. After the work is completed, restoration of fluid pressure will remove the bread, allowing the system to operate in the usual manner. The sketch shows details.



Stuffing low pressure pipe with bread will stop drainage while work goes on

Remember the trick of repairing a leak in an underground water main by wiping dry cement around the pipe, to form a "pig"? Or the old-timer's method of cleaning boilers with potatoes or coffee grounds?

▶ **WILL READER C. J. GONNELLA** kindly send us his correct address? He asked, in a letter of July 19, for a copy of *This Is the Power Engineer*, also for some information about Handbook pages. We replied to the address he gave, sending a copy of the brochure, but the post office has returned it to us marked "no such number". Account for yourself, Mr. Gonnella!

▶ **AN ENGLISH "FIRST"** in gas turbine development gleams out of this invitation which has been extended us in a letter from G. B. R. Feilden, engineering director of Ruston & Hornsby, Ltd, with headquarters in Lincoln (England, of course, not Nebraska):

> When you are coming to Europe again, I do hope you will let us know, as we would like to show you the development which has taken place in our gas turbine organization. We are proud to have what we believe is the only production line for industrial gas turbines in Europe, and our sales continue to go ahead in a most encouraging manner.

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

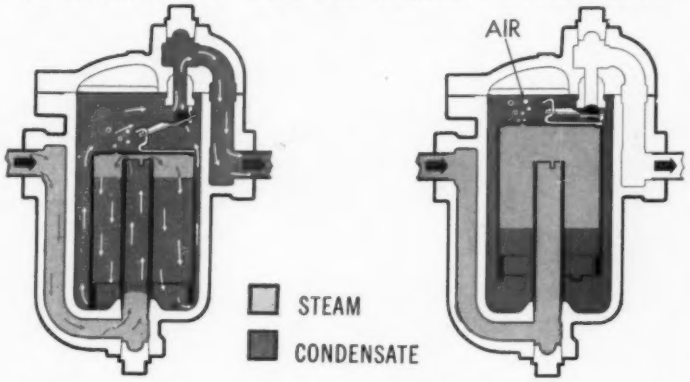
By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8105 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

For more data circle 505 on Post Card

WELBOND®

is the valve

for high pressures, high temperatures

Yarway Welbond Valves are available in 9 sizes, ¼" to 2½", angle and straightway designs. Pressures to 2500 psi, temperatures to 1050° F.

Welbond is the valve designed by Yarway specifically to provide modern steam power plants with the ultimate in high pressure, high temperature valve service.

These special Welbond features insure improved valve performance:

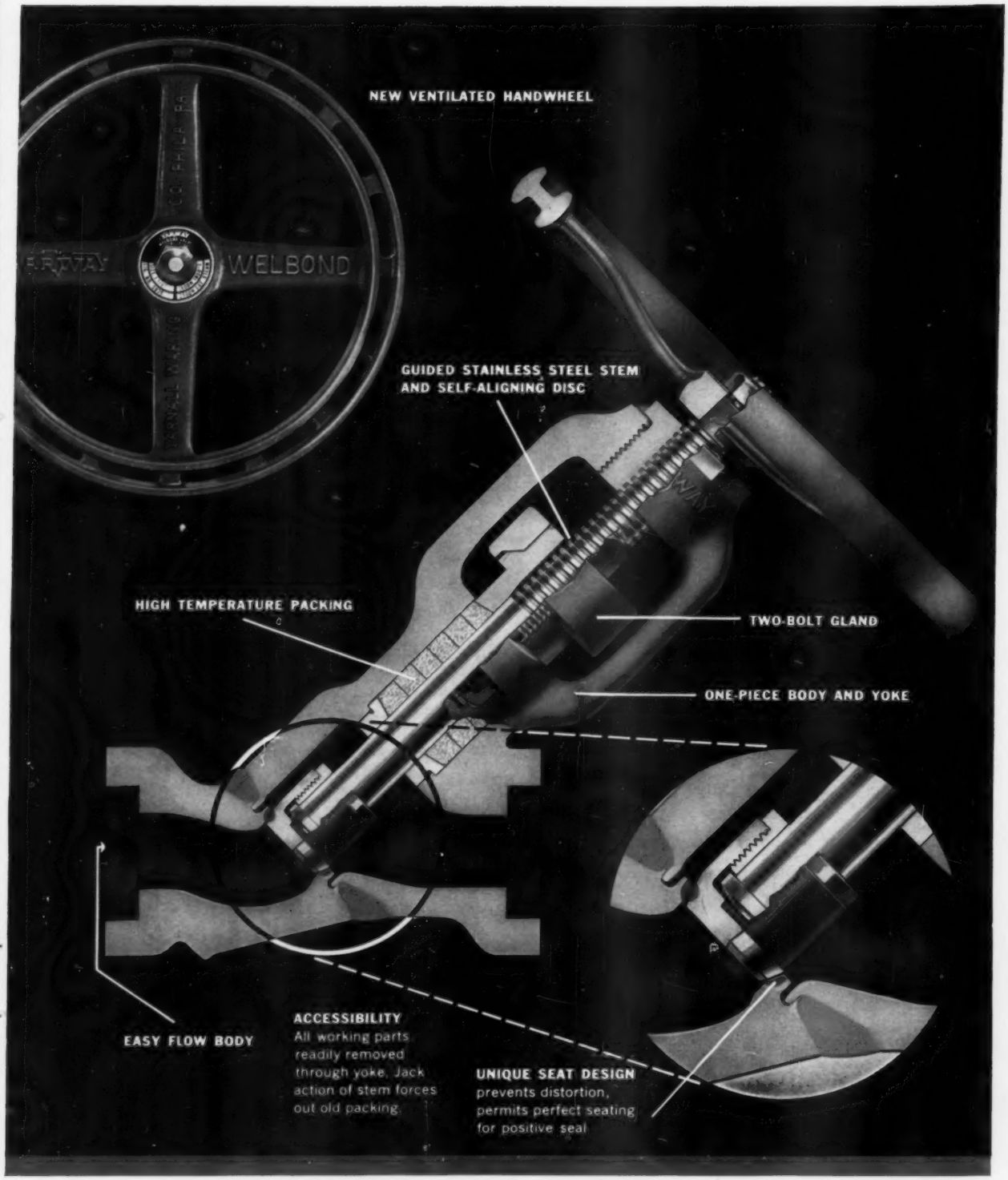
- **Stem** of 321 stainless steel, used with special **packing** to prevent stem corrosion
- Easy and quick **accessibility.** All working parts removable through yoke.
- Non-distorting, thermally-compensated **seat**
- Ventilated, easy grip **handwheel**
- **Streamlined flow** through body

Welbond Valves are winning approval on superheater vents and drains, water wall drains, economizer drains, steam gage shut-off, strainer blow-off and many other steam plant services. Your Yarway man will be glad to discuss applications for your plant.

For full information, write for Yarway Bulletin B-452.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

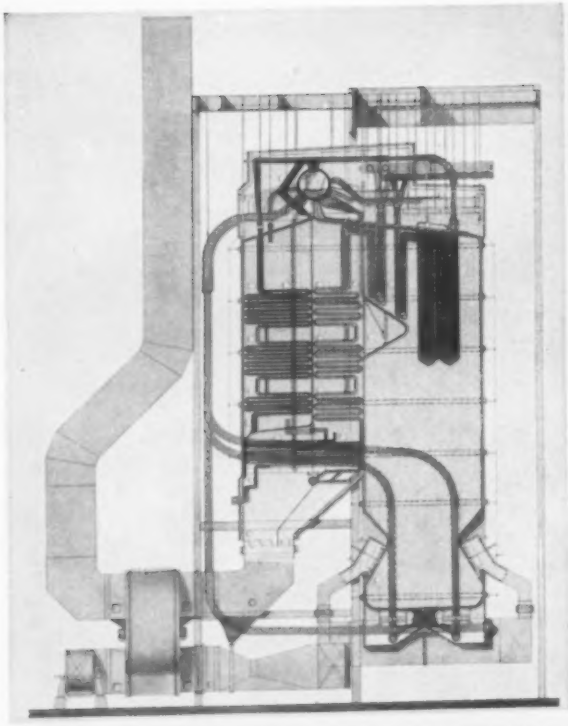
YARWAY WELBOND . . . a good

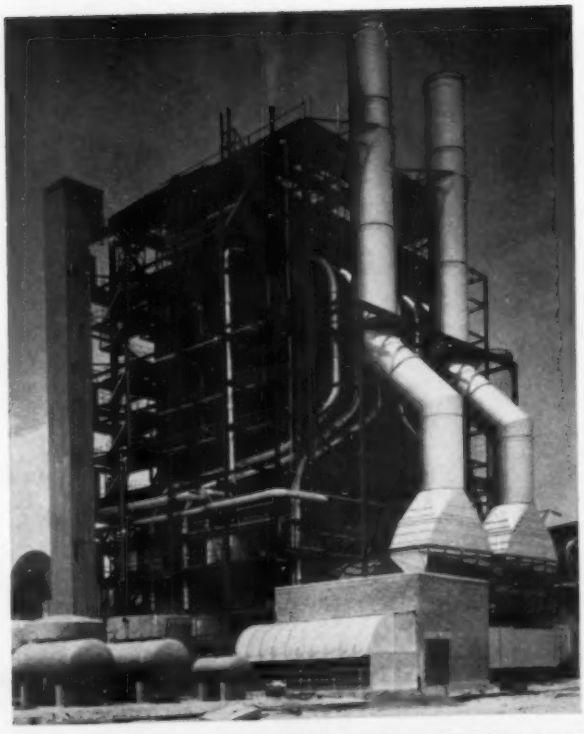

NEW VENTILATED HANDWHEEL
WELBOND
GUIDED STAINLESS STEEL STEM
AND SELF-ALIGNING DISC
HIGH TEMPERATURE PACKING
TWO-BOLT GLAND
ONE-PIECE BODY AND YOKE
EASY FLOW BODY
ACCESSIBILITY
All working parts readily removed through yoke. Jack action of stem forces out old packing.
UNIQUE SEAT DESIGN
prevents distortion, permits perfect seating for positive seal

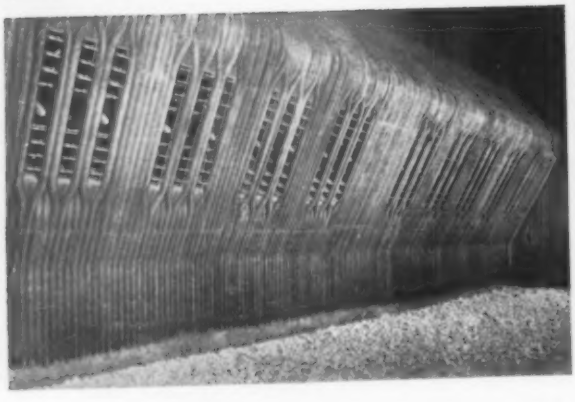
way to specify high pressure/high temperature valves

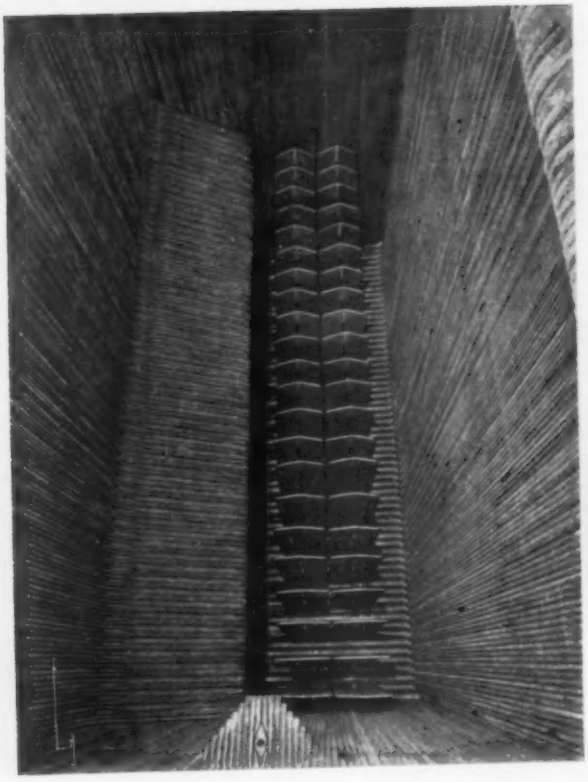
For more data circle 506 on Post Card

Performance







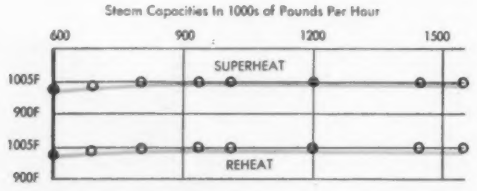


# of RILEY TURBO FURNACE Reheat Unit At Sterlington Steam Electric Station

Exceptional From Start-Up!

Unit Capacity — 1,550,000 lbs/hr
Pressure — 2175 Psig
Superheat and Reheat — 1005F

Wide Range of Steam Temperature Control

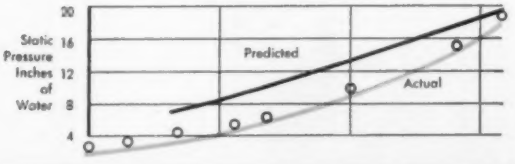


Low Air Heater Exit Gas Temperature

High Unit Efficiency

Low Forced Draft Fan Pressures

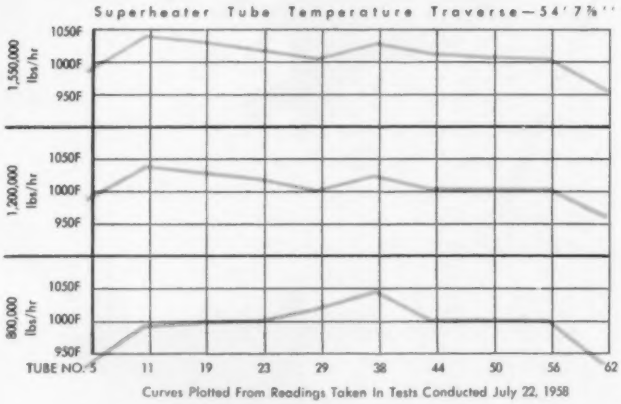
Low Auxiliary Power



Minimum Superheater Metal Temperature Variations Across 54 Ft. Wide Furnace

This results from the fact that the Riley Directional Flame Burners, arranged for opposed firing, produce uniform combustion across the entire 54' 7⅞" width of this Turbo Furnace which has no water cooled platens or divided walls. Gases rise evenly and vertically within the furnace envelope.

Views of Louisiana Power & Light Company's Riley Unit at Sterington illustrate the characteristic TURBO FURNACE bottom and some of the 20 Directional Flame Burners.



Curves Plotted From Readings Taken In Tests Conducted July 22, 1958

FOR TURBO FURNACE DETAILS — WRITE RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS

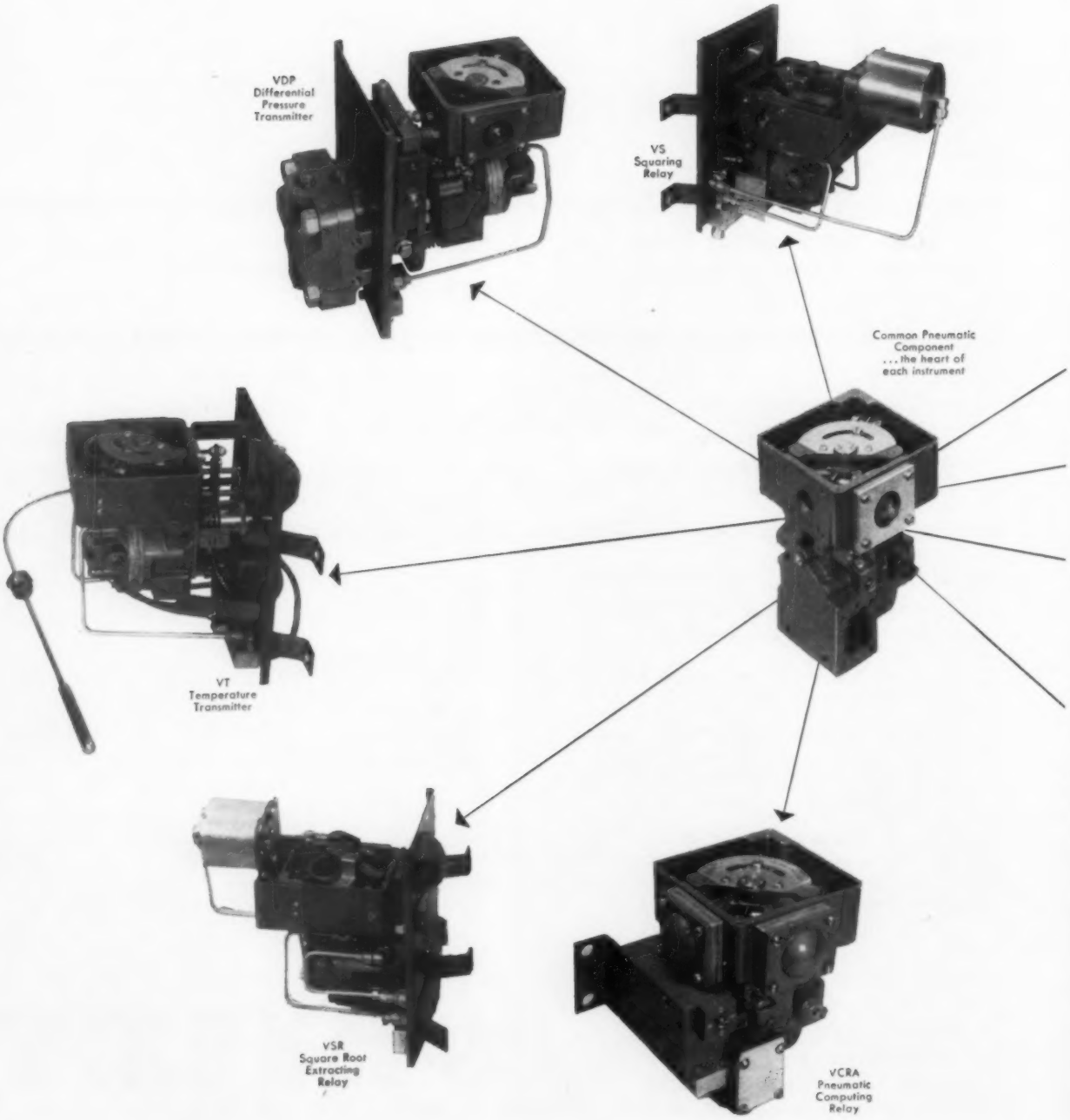
A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT

For more data circle 507 on Post Card

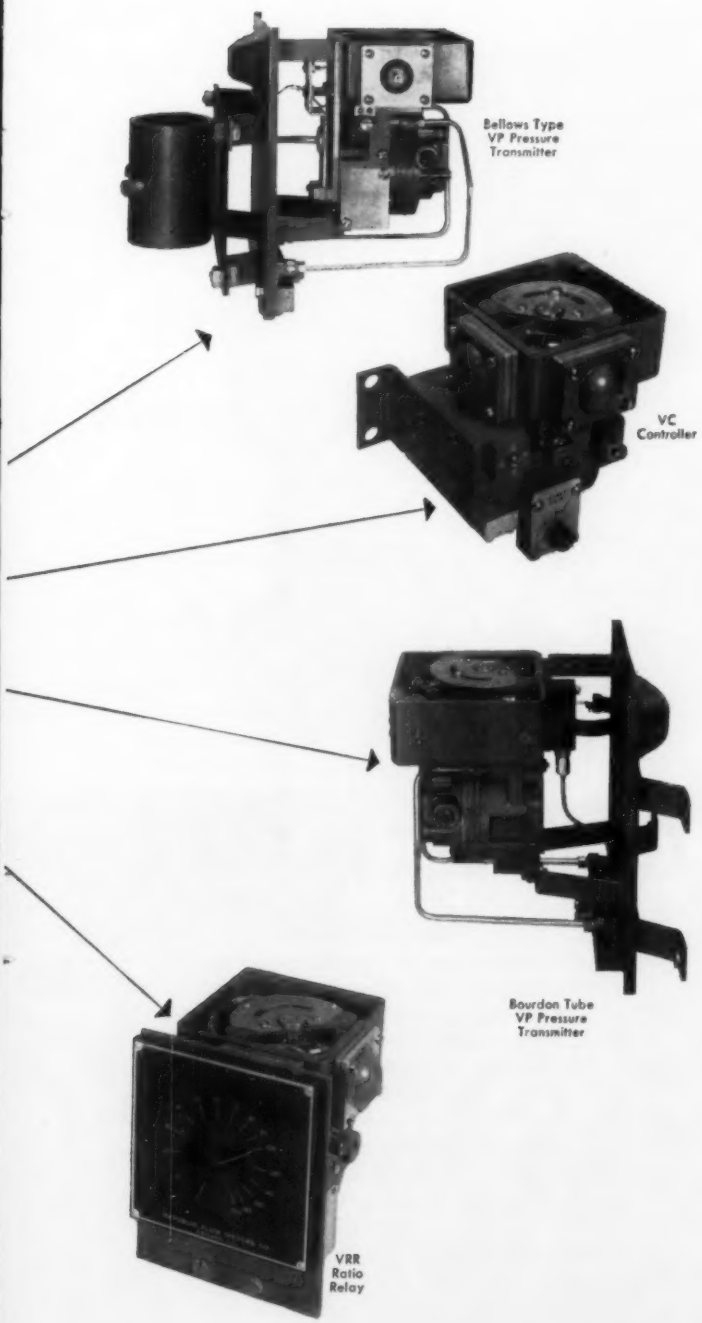
Rockwell-Built REPUBLIC

serve any process,



VECTOR SERIES INSTRUMENTS

cut costs too!



You can save substantial money when your control systems are based on Republic's Null-Balance Vector instruments. Each has as its "heart" an identical pneumatic component, with obvious advantages. Among these are interchange of parts, even among instruments performing entirely different functions. Besides involving a minimum spare parts inventory, this feature greatly simplifies personnel training.

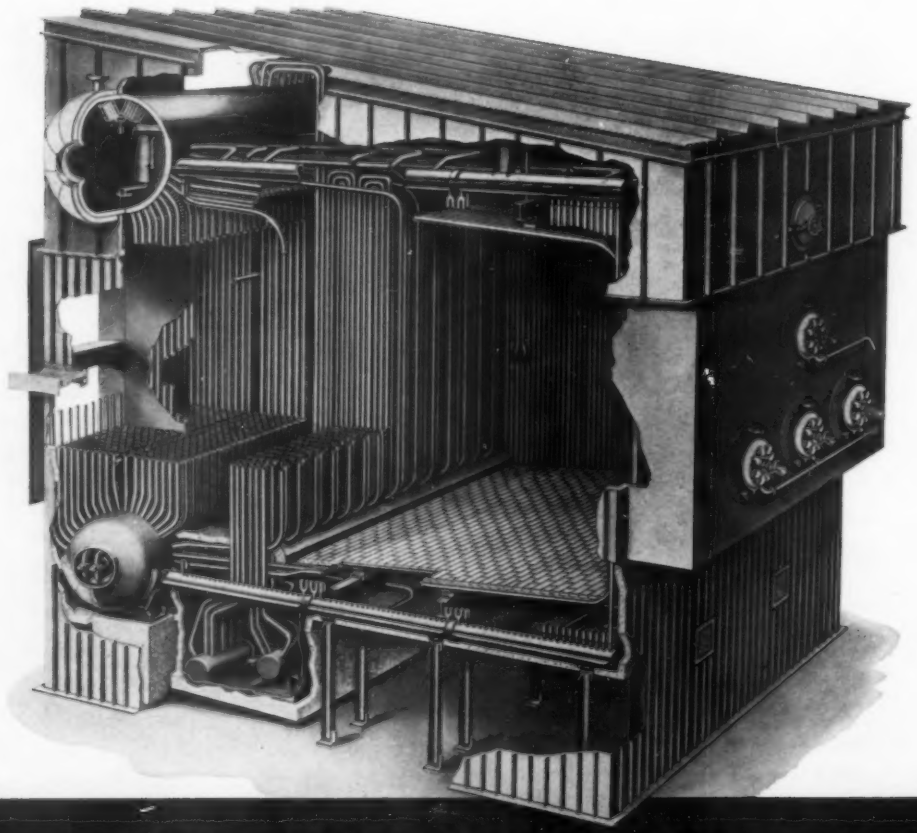
Components shown demonstrate the depth of the Republic line. Differential pressure transmitters with 20-to-1 range adjustment . . . temperature transmitters with 10-to-1 range adjustment . . . pressure transmitters of ±0.5% accuracy. We have ratio, totalizing, multiplying, squaring and square root extracting relays. Our all-purpose controllers feature proportional band adjustment of 2% to 500% and reset adjustment from 0.1 to 50 repeats per minute.

The Republic Engineer in your area will be glad to work with you on any control or measurement problem. Sales offices in principal cities throughout the United States and Canada. Call or write—with no obligation, of course—*Republic Flow Meters Company*, 2240 Diversey Parkway, Chicago 47, Illinois (subsidiary of Rockwell Manufacturing Company). In Canada: Republic Flow Meters Canada, Ltd., Toronto.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

For more data circle 508 on Post Card

Designed For Tomorrow's New, Economical



HERE ARE 8 WAYS IN WHICH THE PFI BOILER CAN BE OF BENEFIT TO YOU:

1. It requires a minimum amount of space for a given power output.
2. The pressurized furnace design assures economy by eliminating the induced draft fan and air infiltration. This means savings in cost of fans, fuel, and operating power.
3. Pre-assembly of many of the components of the PFI Boiler is controlled in B&W shops, resulting in a reduction of the time and manpower required for field erection.
4. The PFI is designed to burn oil, gas, or a combination of the two. When it is equipped with a dual-fuel burner, it allows you to take advantage of favorable market conditions.
5. Cyclone Steam Separators ensure adequate water circulation which protects boiler tubes from overheating, even with wide and frequent changes in load. They also give you clean, dry steam at all designed ratings with high boiler water concentrations.
6. The drainable superheater design assures quick, safe start-up and ease of storage.
7. Water-Cooled Burner Throat eliminates troublesome maintenance, costly repairs.
8. All-welded Membrane Wall contributes to high efficiency and reduces insulation requirements.

Plants
Power For Industry

New B&W
PFI Oil-Gas Burning Unit Provides Maximum Output in Minimum Space

Here's an answer to industry's need for an economical, dependable steam supply. The new B&W Integral-Furnace Boiler produces high-quality, dependable steam economically at all ratings. Aptly named the PFI, the "Power for Industry" Boiler is compact, easy to install, quick to meet rapid and wide load swings. The new boiler gives long, sustained operation, requires little attention and is readily accessible for inspection, cleaning and maintenance.

All responsibility for your complete delivered and erected unit is accepted by one experienced, dependable source which in the past 25 years alone has placed over 4,000 Integral-Furnace Boilers in service. Behind *every* B&W Boiler is nearly a century of leadership in steam generation. A national network of B&W plants and engineering facilities means that the special skills of B&W engineers are always quickly available to you for service and assistance. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

For further information about the B&W PFI Boiler, write for Bulletin G-94.

BABCOCK & WILCOX

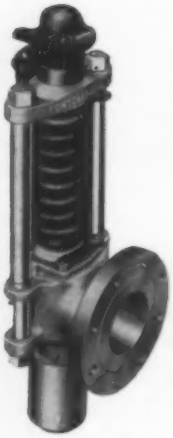
BOILER DIVISION

G-899

For more data circle 509 on Post Card

STOPS VALVE LEAKAGE

at high pressures



Consolidated "Maxiflow" Safety Valve, Type 1700 Series, Sizes: 1½" thru 6".

The Thermodisc Seat in Consolidated "Maxiflow" Safety Valves solves the problem of valve leakage at high pressures, saves steam and reduces maintenance.

Research has shown that when a safety valve on high pressure service reseats after popping, a small amount of leakage occurs momentarily between seat and disc before the valve seals off and becomes tight. This leakage is comparable to steam flow through small, individual orifices.

When a small steam leak exists at some point on the valve seat, the area near the point is cooled by the refrigeration effect of the escaping vapor. The metal tends to contract causing slight deformation of the seat. This acts to increase the gap size between disc and seat bushing at the leakage point. The size of the gap increases rapidly until the rate of leakage becomes extremely high.

The Thermodisc Seat prevents seat distortion and consequent leakage with a seat element recessed to form a thin wall at the area of seat contact. This design permits a high rate of heat-transfer in the metal *that eliminates all thermal differences.*

The result is a degree of tightness, essential to the operation of safety valves in high pressure services, never previously achieved. For complete details, write for Bulletin 707B.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

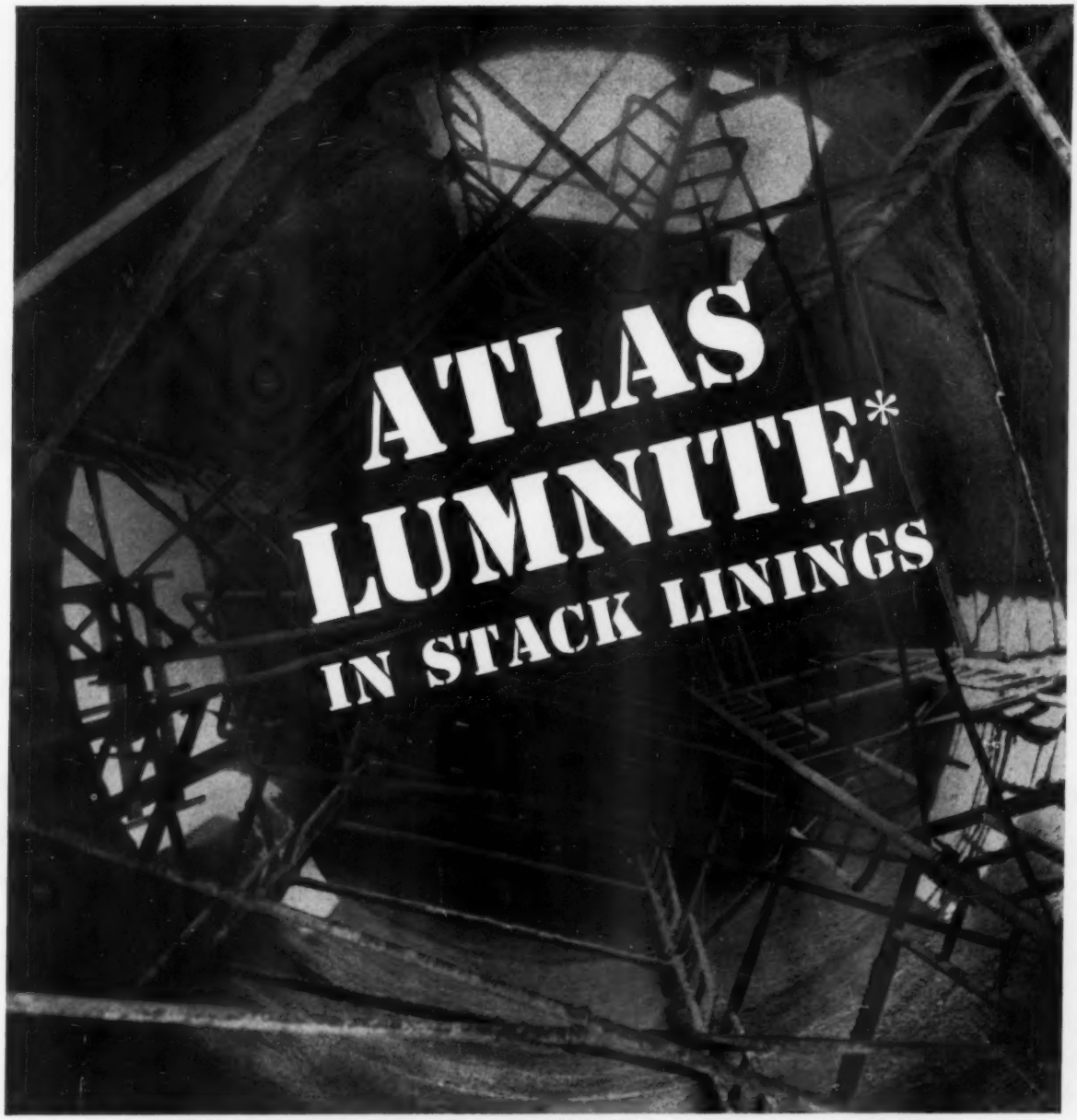
CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data circle 510 on Post Card



Looking up a 200-ft. power-plant stack being lined with corrosion-resistant concrete made with LUMNITE cement. One of two stacks (Units 4 and 5) of Pacific Gas & Electric Company's Contra Costa Power Plant near Antioch, Calif. Gunite Contractor: Johnson Western Gunite Co., Gardena, Calif.

- Industrial concretes, made with LUMNITE calcium-aluminate cement and suitable aggregates, resist heat, corrosion, abrasion, thermal shock – and provide insulation.
- Placement is fast and easy – by guniting, pouring or plastering.
- Downtime is reduced to a minimum because concretes made with LUMNITE cement are ready for service in 24 hours.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

Write for a copy of the "Lumnite Mortar Manual," describing gun-applied linings:
Universal Atlas, 100 Park Avenue, New York 17, N.Y.

*ATLAS *and* LUMNITE *are registered trade-marks*

UNIVERSAL ATLAS CEMENTS

Universal Atlas Cement
Division of United States Steel

USS TRADE MARK

L-168

OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*

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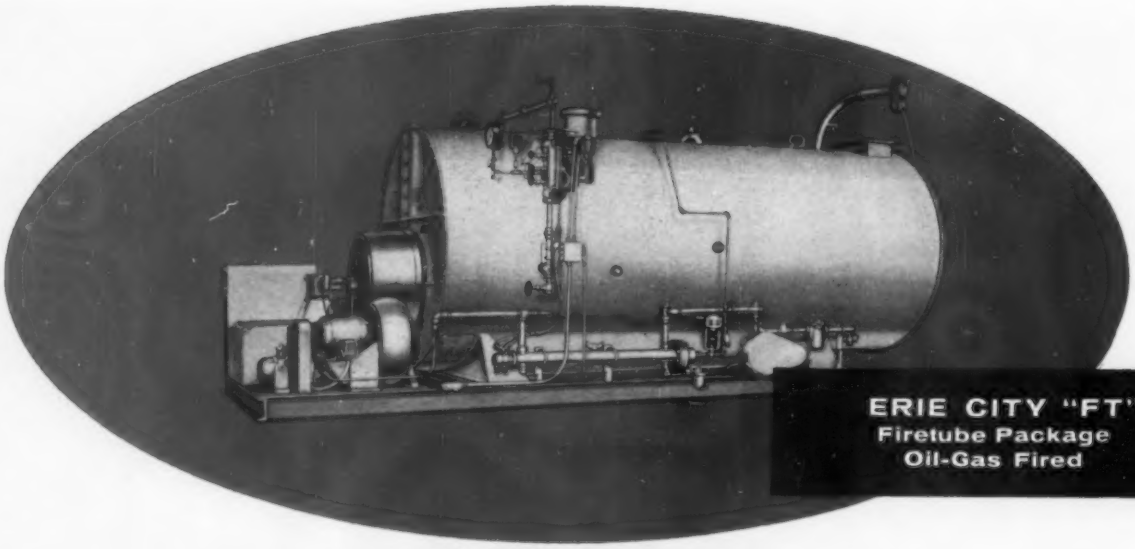
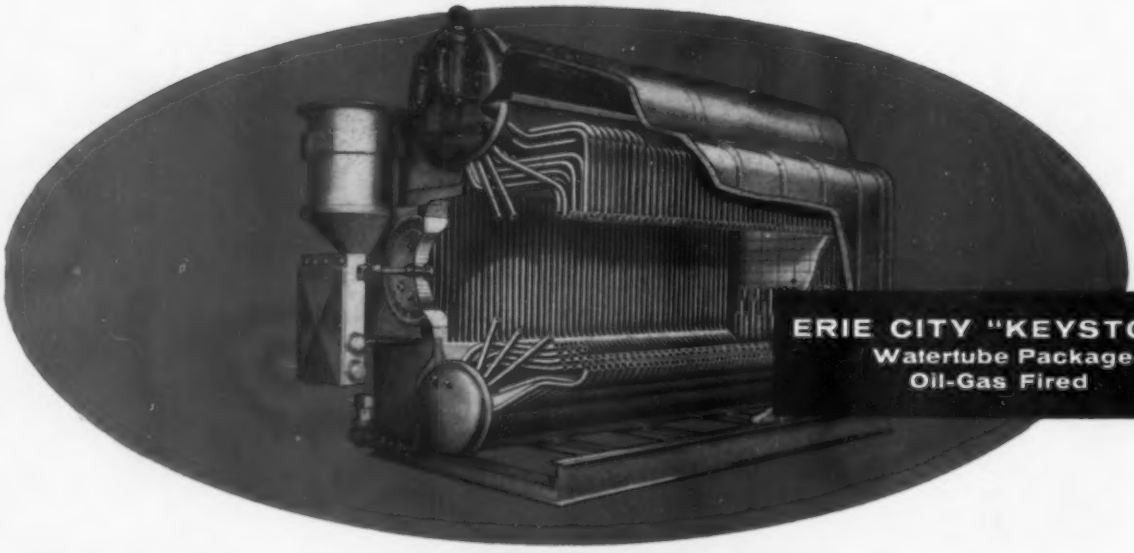
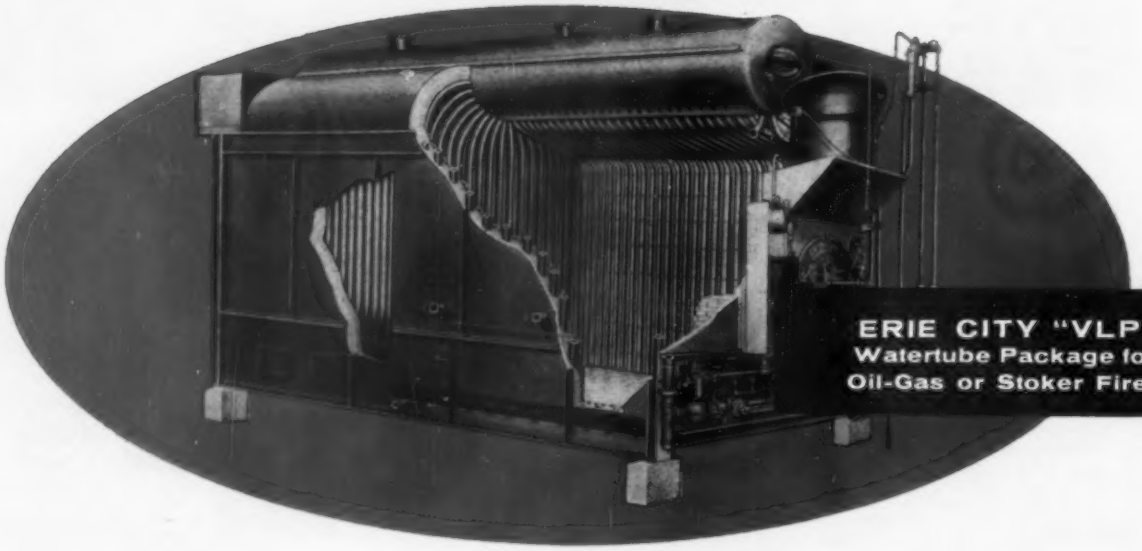


ERIE CITY "FT"
Firetube Package
Oil-Gas Fired



ERIE CITY "KEYSTONE"
Watertube Package
Oil-Gas Fired



ERIE CITY "VLP"
Watertube Package for
Oil-Gas or Stoker Fired

Why shop around for Package Boilers?

Thinking about a new boiler these days? Maybe a package boiler! Sounds like a good idea because many people like this new concept of undivided responsibility. But what kind should we get? Firetube? . . . Watertube? Should it be oil fired, gas fired, arranged for future stoker firing; or which combination of these would be best for us?

The best place to find unbiased answers to your questions is Erie City Iron Works—a pioneer in the boiler industry and a leader in the package steam generator field. Erie City manufactures both firetube and watertube package units. Without prejudice their engineers can point out the advantages of both types.

After hearing the pros and cons of each, you may decide on the firetube type. Erie City offers its modern "FT" Package Boiler arranged with Erie City air atomizing oil gun and/or ring type gas burner. The "FT" Fire Tube Package unit is built to highest quality standards—not down to a price. It is a three pass design with gas vent at the rear and pressurized, using forced draft to provide precise control of excess air and CO_2. A centrifugal fan is used, which coupled to a closed combustion chamber, results in unusually quiet operation. No costly foundation—no expensive stack—no brickwork are required.

If a watertube boiler is your choice, you have two types available from Erie City. One is the KEYSTONE, the most compact water tube package available, arranged with a steam atomizing oil gun and/or ring type gas burner. The KEYSTONE is a baffleless, two drum unit completely water cooled with a seal welded inner casing and bolted outer casing for pressurized operation. No costly foundation—no expensive stack—no brickwork are required.

The other choice for a watertube package is the VLP. Your plant may be located in an area where gas, oil and coal are all available. At first you may decide to fire with oil or gas but desire the proper provision for future coal firing. The boiler for you to install is an Erie City VLP arranged for present oil and gas firing but with the furnace PROPERLY PROPORTIONED for the future installation of an underfeed or spreader stoker.

All Erie City package units come complete with burners, fans and safety and combustion controls, piped, wired and mounted on the boiler. No field work required—just make basic fuel, water, steam and electric connections and you're ready for operation.

Both the air atomizing and steam atomizing burners are of Erie City's own design and manufacture. No division of responsibility here. Qualified service engineers will assist at start up and instruct your operating personnel. In the case of the VLP, your boiler will be properly designed for future conversion to either Erie City underfeed or spreader stoker firing. Again, no division of responsibility.

Don't let the selection of a new boiler become an unnecessary problem. Write and let Erie City help make the proper selection of a package steam generator for you.

"FT" *Cat.* SB5682K

"KEYSTONE" *Cat.* SB5982K

"VLP" *Cat.* SB5782K

• *You can depend on* ERIE CITY Since 1840 *for sound engineering*

ERIE CITY IRON WORKS *Erie, Pennsylvania*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS • WASTE HEAT BOILERS
FIRE and WATER TUBE PACKAGE BOILERS • OIL and GAS BURNERS • STOKERS • PULVERIZERS

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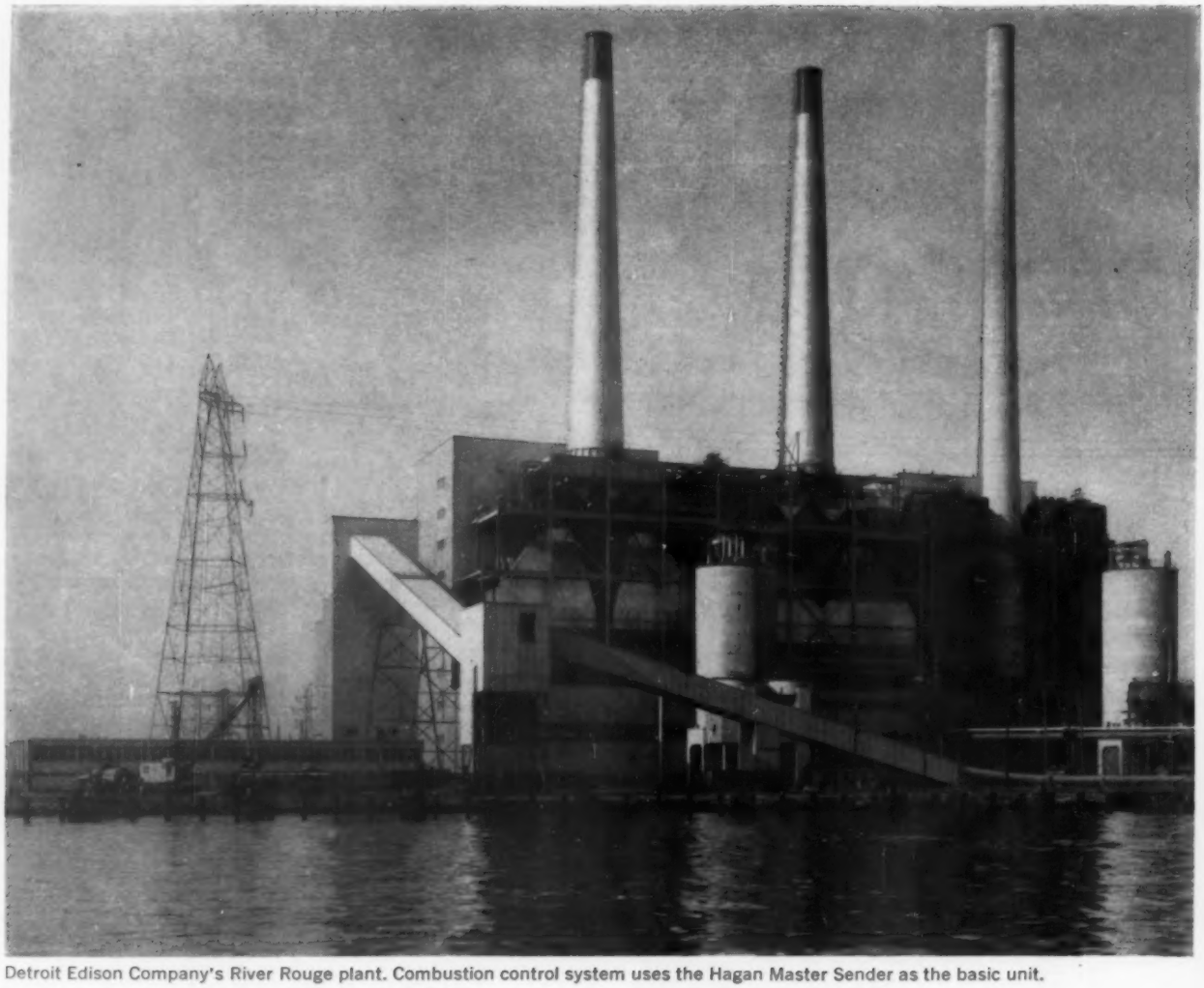
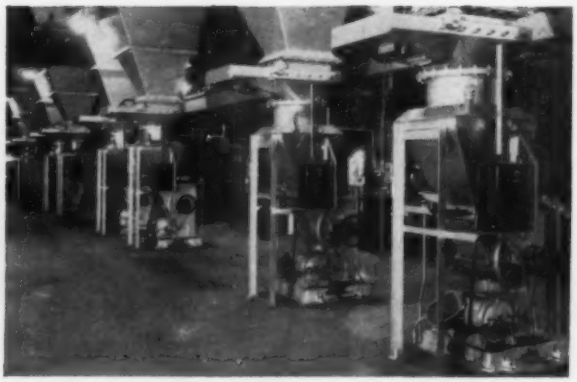


Detroit Edison Company's River Rouge plant. Combustion control system uses the Hagan Master Sender as the basic unit.

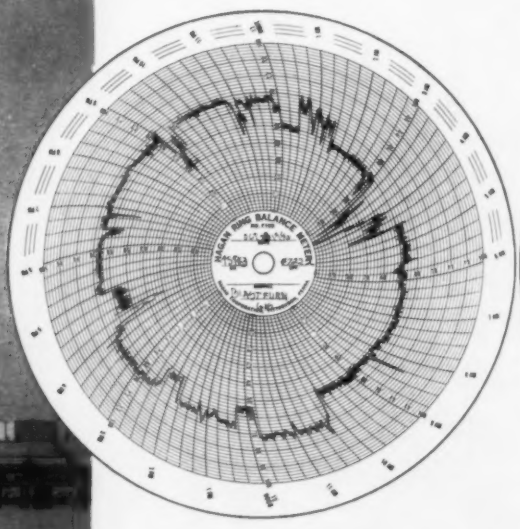
HAGAN CONTROLS ALL THREE BOILERS

Control panel and Console at the River Rouge plant. Close check on all phases of station operation is facilitated by the high accuracy of the Hagan Ring Balance meters.

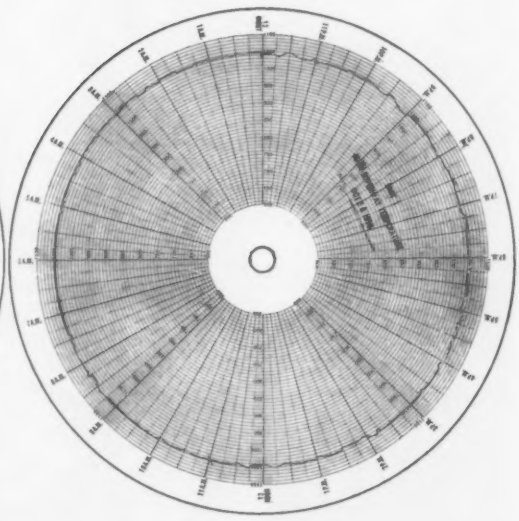


Main firing aisle. Here Hagan Power Positioners regulate the flow of pulverized coal to meet steam demand accurately and dependably.

BLAST FURNACE GAS



MAIN SUPERHEAT TEMPERATURE



This comparison of Blast Furnace gas flow and Main Superheat Temperature shows how closely Hagan control maintained the set point, regardless of the fact that BF gas flow fell to zero almost instantaneously at one point. Note the suppressed range of the superheat temperature chart (600°F-1100°F), each division is only 10°.

AT DETROIT EDISON'S RIVER ROUGE PLANT

Detroit Edison Company's River Rouge plant easily qualifies as one of the nation's largest steam generating plants. It has three huge twin-furnace boilers, each made by a different manufacturer. *But all three boilers* are equipped with Hagan Combustion Control, Hagan Steam Temperature Control, Hagan 3-Element Feedwater Control and Hagan metering.

Fuels used are pulverized coal and blast furnace gas from a nearby steel mill. In spite of wide and sudden variations in the flow of BF gas, steam temperature and header pressure are held within established close limits. Steam temperature control includes flue gas recirculation and attemperation for unit #1; burner tilt and attemperation for unit #2; firing split control with a heat-exchange type attemperator for unit #3.

Hagan 3-element feedwater control system has proven advantageous during startup, blowdown, and shutdown periods. Fully compensated for variations in pressure and temperature, the Hagan system permits maintenance of accurate automatic control over a wide range of operating conditions.

Hagan's experience with the design and construction of control systems for every type of boiler, plus leadership in the exact control of multiple fuel firing, was a valuable asset in building the River Rouge systems. Hagan's highly qualified field engineers also contributed to the rapid and successful completion of this unusual installation.

Hagan skills and experience are available to you. A letter or phone call will bring complete information, or a Hagan engineer will be glad to discuss your particular problem.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

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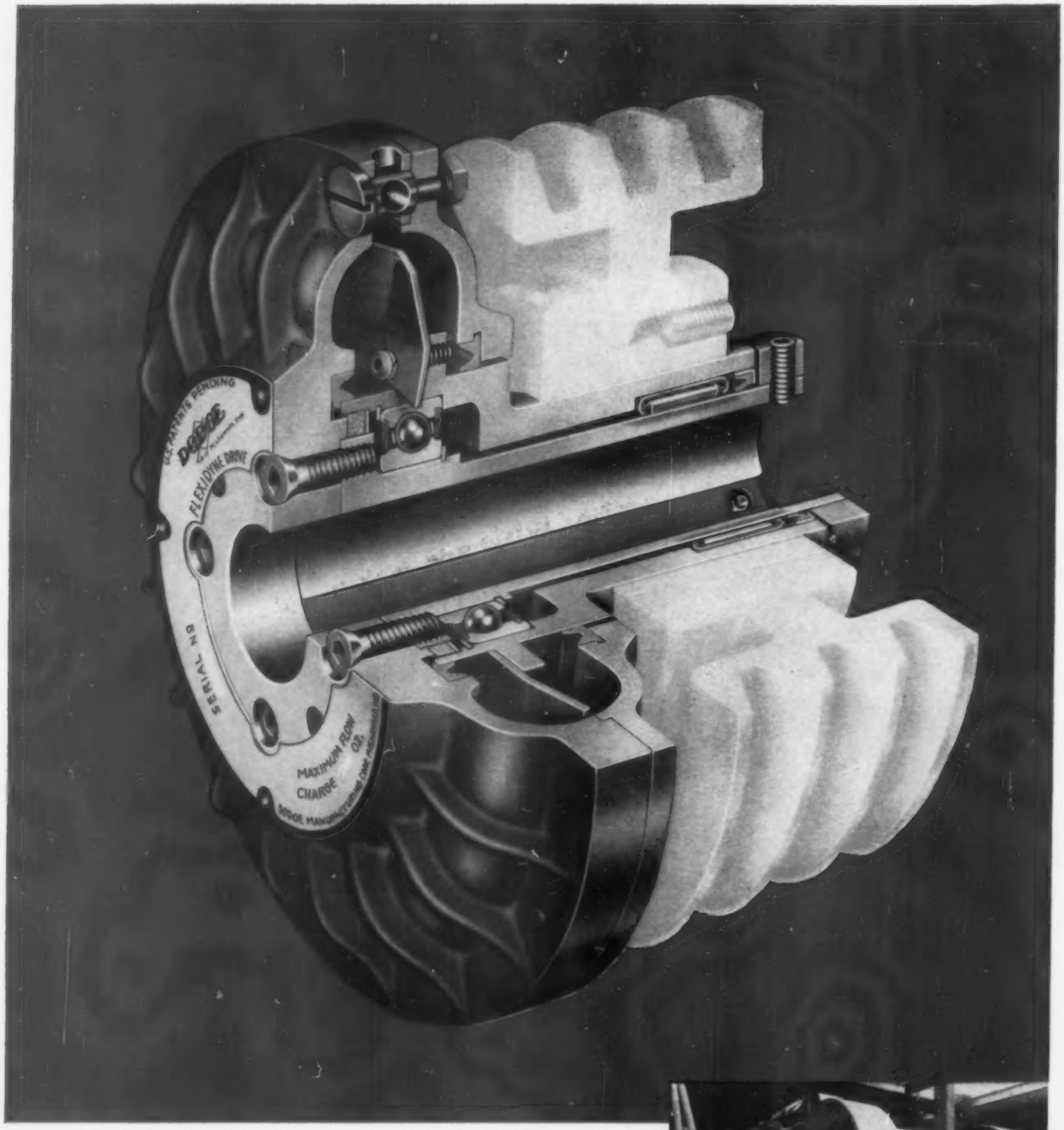
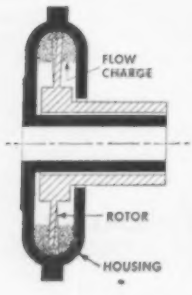
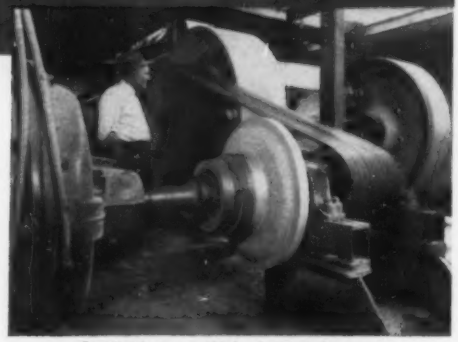




HOW FLEXIDYNE WORKS

The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.



Overloads on a 150 hp jaw crusher cause sudden damage. Here Flexidyne is used to minimize this costly trouble. As a bonus, it reduces belt wear and replacement.

FLEXIDYNE

THE DRY FLUID DRIVE

OFFERS A NEW APPROACH TO DIFFICULT DRIVE PROBLEMS...OPENS THE WAY TO MULTIPLE SAVINGS!

IT IS NO LONGER NECESSARY to accept the destructiveness—the costliness — of conventional starting in the mechanical transmission of power! Flexidyne changes that.

LOOK AT YOUR DRIVES! Are you using expensive oversize or high torque motors merely to get your loads started? Are you using expensive starting equipment? Are you tolerating high demand rate? Are your belt maintenance costs high, because of the shock of across-the-line starting?

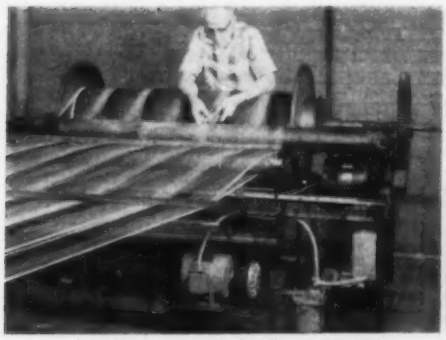
HOW ABOUT THE MATERIAL YOU PROCESS—wire, paper, textiles? Is your output hampered by breakages that you accept as "normal production"? Do you burn up clutches in getting your loads up to speed?

FLEXIDYNE—THE DRY-FLUID DRIVE—solves these problems—and many more! Flexidyne is revolutionary. *And so simple!* Off the shelf availability. Drives or Couplings. Fractional to 1000 hp. Ask your local Dodge Distributor or write us for technical Bulletin.

DODGE MANUFACTURING CORPORATION, 6400 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER —your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.



Flexidyne, accurately set for extra gentle starting, solves the problem of thread breakage on this textile beam warper—vastly multiplying productivity.

Smooth starting and deft spotting are required with this 20-ton crane. Flexidyne accomplishes both—and by so doing saved $4,000 in electric controls!

A ball mill drive is a tough one. Flexidyne not only eases heavy starting shocks here but eliminates the necessity *and the cost* of an oversize motor!

For more data circle 514 on Post Card

Here's what you can do about the high cost of fuel

Get the same heat from less fuel with a

Ljungstrom® Package Air Preheater

A significant amount of your fuel is used to heat the combustion *air* in your boilers. A Package Ljungstrom Air Preheater raises the temperature of combustion air by recovering the heat from the exhaust gas. In preheated air, the fuel you are now using will burn more completely, and much more of it will be *productive* heat.

Here is an example of what this means in dollar savings. In one year (1956) a typical Package Ljungstrom installation saved $17,600 in fuel costs. In some installations the Package Ljungstrom saved enough fuel to pay for itself in two years.

Compact Package design of the Ljungstrom gives you all the advantages and economies of the Ljungstrom in a preassembled unit. The Package Ljungstrom is available in vertical or horizontal models that are readily adaptable to any plant arrangement.

For further information, write today for the free 14-page Package Ljungstrom manual.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more data circle 515 on Post Card

HELPFUL BULLETINS

LUBRICATION

101 Planned Lubrication — Twenty-pp Bulletin BK-19 lists correct lubricants for specific types of equipment operating under normal conditions of speed and temperature. This aids in selection of right lubricant for the job and also shows how most requirements can be met with a minimum of different lubricant types and densities. Characteristics, uses, specifications and densities are listed. Keystone Lubricating Co.

102 Lubrication Equipment — Catalog 65, 32 pp, presents industrial lubrication equipment, including drum-pumps and Lubriguns, pressure primers and pump elevators, measuring valves, hose reels and accessories, also Centr-O-Block lubrication systems. Generously illustrated, book provides brief application suggestions, descriptions of features and selection charts. Lincoln Engineering Co.

PUMPS, COMPRESSORS

103 Centrifugal Pumps — Bulletin 721.6, 16 pp, describes single stage, double suction centrifugal pumps with horizontally split cases, available with grease- or oil-lubricated bearings, and offering standardization and interchangeability of parts. Bulletin provides specifications, sectional views, and charts of materials of construction, parts list and parts interchangeability. Includes mechanical data, performance curves. Goulds Pumps, Inc.

104 Gas Pumps — Six-pp Bulletin XA-458 covers company's rotary positive gas pumps offering a wide range of capacities, pressures and drives. Technical rating data is included, along with detailed design and construction data. Roots-Connersville Blower, Div. Dresser Industries, Inc.

105 Medium Pressure Compressors — Bulletin LAH-158 presents Spiraxial compressors in capacities from 1000 to 12,000 cfm for pressures to 15 psig, giving design and construction data as an aid to selection and application of this equipment in many process industries. Ratings and capacities for 17 sizes are listed in the bulletin. Roots-Connersville Blower, Div. Dresser Industries, Inc.

INSTRUMENTS, CONTROLS

106 Versatile Recorder — Included in this bulletin on company's Universal electronic recorder, are details on two types of electronic receiver units, direct pressure and temperature receivers, amplifier, integrator and accessories. General construction and design details included. The Hays Corp.

107 Propeller Meters — Twenty-pp Bulletin 314-1 covers propeller meters and other water measurement and recording instruments. Some of the principles of propeller metering are presented along with performance graphs of each type. Recorders and their application, remote controlling are also discussed. Also included are accuracy and head loss curves. Sparling Meter Co.

108 Plastic Flow Tube — Bulletin 115-R1 describes the lightweight, low cost, corrosion resistant inert plastic Dall flow tube. Model DFT-PI. Includes photos, dimensional and cost-comparison tables, cutaway views, and performance charts. Builders-Providence, Inc.

109 Feedwater Regulation — Company's BI feedwater regulator, a single-element unit employing a thermostatic-tube level controller which actuates a regulating valve in the feed line, is described in Bulletin 1044. Illustrates working parts and a schematic diagram shows how units are arranged into a complete control system. Also tabulates specifications, lists features. Copes-Vulcan Div., Blaw-Knox Co.

110 Temperature Detectors — Information on company's Thermohm detectors (resistance thermometers) for temperatures to 1000 F is offered in 36-pp Catalog EN-S4. Tells how these primary elements are used in chemicals, food and drugs, glass, metalworking, petroleum, steam and power generation applications. Fully illustrated, catalog lists Thermohm specifications by application and design. Leeds & Northrup Co.

111 Thermocouple Data — Applications, advantages and materials of construction of Ceramo furnace tube wall thermocouples are covered in this engineering data bulletin, about 16 pp. Contains diagrams of typical furnace tube wall thermocouple installations; catalog sections describing components in such an assembly (thermocouple extension wire, thermocouples, thermowells, connection heads and fittings); and a data sheet for recording the necessary specifications. Thermo Electric Co., Inc.

112 Liquid Level Gages — Condensed Catalog 335, 8 pp, illustrates standard and special function gages and valves. Dimensional drawings, pressure-temperature graphs and ratings, tables of sizes, and specifications are included, and construction features, materials, and standard and optional features described. Jerguson Gage & Valve Co.

113 Leak Detectors — Bulletin GEA-6817, 12 pp, describes in text, tables and pictures, characteristics and applications of leak detectors for any system or component under pressure or vacuum. Special emphasis is given to a new control which can be used with any of the four detector heads. Contains technical data on the four models and information on accessory equipment. General Electric Co.

114 Ion-Exchange Controls — Six-pp Bulletin E-156 describes automatic controls for ion-exchange equipment. Various elements in the control cabinets, as well as all the power-operated units, are covered and construction features detailed. Specifications are included. Illinois Water Treatment Co.

FANS AND BLOWERS

116 Rotary Positive Blowers — Eight-pp Bulletin AF-258 describes operation and construction features of company's rotary positive blowers. Detailed design and construction information is presented together with technical data to aid in proper selection and application of this equipment, for either vacuum or pressure. Roots-Connersville Blower, Div. Dresser Industries, Inc

117 Fans and Blowers — Catalog 230, 18 pp, presents features and construction data on electric exhaust fans, duct fans, automatic louvers, penthouses, power roof ventilators, direct drive utility blowers, pressure blowers, radial blade blowers, high speed utility blowers, others. Ratings, dimensions and recommended specifications are included, as well as photos, dimensional and installation data. Fan & & Blower Div., The Peerless Electric Co.

MECHANICAL POWER TRANSMISSION

118 V-S Drives — Bulletin D-2506, 16 pp, describes company's V-S drives, which provide adjustable machine speeds from in-plant a-c circuits. Discusses manufacture and functions of drive components, including regulators, exciters, motor-generator sets, operator's panels. Includes photographs, diagrams, condensed drive specifications, dimensions and accessories. Reliance Electric and Engineering Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 119 and 120.

119 Gear Drive Manual — Twenty-pp Bulletin 965 contains installation, operation and maintenance instructions for company's Type W gear drives, compact quiet-operating units adaptable to a variety of agitated reactions because of extended speed and power range. Engineering data includes dimensions, weights and rated capacities, as well as detail drawings and parts lists. Also given are instructions for dismantling the drive when equipped with rotary seal or stuffing box. The Pfaudler Co.

120 Bronze Bearings — Indexed Catalog 58, 50 pp, enables easy selection of practically any type of sleeve bearings and bushings required for production and maintenance of machine tools, industrial machinery. Covers 866 sizes of cast bronze stock bearings, 553 stock sizes of plain sintered oil-filled thrust bearings. Also included are 267 sizes of cast bronze 13-in. bars and 84 sizes of sintered oil-filled 6½-in. bars from which bearings can be cut. The Bunting Brass and Bronze Co.

WATER TREATING

121 Phosphate Treatments — Bulletin HSP-906, on phosphates for boiler water conditioning, discusses company's phosphate and Buromin for preventing calcium scale and failures, and Burosil, which controls both calcium scale and magnesium deposits. Covers methods of feeding chemicals and testing and con-

trolling residual phosphate and contains five case histories of products in use. Hagan Chemicals & Controls, Inc.

122 Hydrogen Zeolite Softener — Eight-pp Bulletin 4530-A indicates advantages of the hydrogen zeolite process, its chemistry and variations in methods for neutralizing mineral acidity of hydrogen zeolite effluent. Types of zeolites are discussed as well as relative advantages and disadvantages of various regenerants. Cochrane Corp.

123 Condensate Demineralization — Reprint 88, 12 pp, discusses high flow rate demineralization of condensate for boiling water reactors. Describes method and operation, including design data, of an ion exchange plant designed and built to treat 3200 gpm of water for nuclear steam generators at 50 gpm per sq ft. Infilco Inc.

REFRACTORIES

124 Castable Refractory Linings — Eight-pp Form 75 describes monolithic linings for full protection of stacks and breechings, utilizing castable refractories. Covers structural and installation advantages of one-piece construction, also basic advantages of products used. Gives characteristics for five insulating grades of refractory recommended for this service. Illustrates installations. Plibrico Co.

125 Insulating Fire Brick — Eight-pp Bulletin IN-115A describes insulating fire brick and Sil-O-Cel insulating brick which can be used for more economical control of heat through 3,000 F. Typical applications are listed, and tables of thermal and physical properties included, as well as other data. Johns-Manville.

DUST, FLYASH CONTROL

132 Dust Control System — Advantages offered by company's Chem-Jet dust control system for coal handling operations are illustrated and described in this 6-pp bulletin. Principle employed in the system is discussed and equipment required is mentioned. Chart shows moisture requirement per ton of coal. Johnson-March Corp.

133 Flyash Collection — How one company has automated flyash collection and disposal is the subject of this 8-pp illustrated bulletin. Installation of the dust-collecting system, consisting of first-stage cyclones and second stage electrostatic precipitator, is detailed. Buell Engineering Co., Inc.

OIL TREATING

134 For Oil Conditioning — Facts about Fil-Thermo-Vac, an oil conditioning system, are given in this 12-pp brochure. The device is designed to remove contaminants from all common oils to 5000 SSU used for lubricating, processing, insulating and other purposes. Tells how the system functions and provides data on sizes and types available, design features. Includes performance curves. Bowser, Inc.

135 Oil Filters — Bulletin F-400 describes filters for full-flow filtration of diesel, gas engine, turbine, lubricating and hydraulic oils and for filtration of various industrial oils, fuel oil, solvents, coolants etc. Provides an easy-to-read data table for selecting proper filter. Specifications include maximum engine horsepower with proper filter listed, number of cartridges etc. Purifier Div., The Hilliard Corp.

Selection Data on Valves, Traps and Couplings

126 Magnetic, Motorized Valves — Within its 24 pages Catalog V-58 illustrates and lists specifications of magnetic and motorized valves for use with air, water, gas, steam, oil and refrigerants. Also included are solenoid coil rating tables. Another feature consists of two flow charts — one for liquid, the other for compressible fluids. Dimensional drawings are included. The Mercoid Corp.

127 Safety Relief Valves — Bulletin P-33 describes safety relief valves for hot water space heating boilers. Diagrams and facts concerning selection and installation of relief valves in keeping with the ASME requirements are given. A table lists complete line of relief valves, size, and type to be used for boilers of various Btu ratings from small to large boilers. McDonnell & Miller, Inc.

128 Industrial Valves — Condensed Catalog CD-2, 28-pp, describes most of this manufacturer's industrial valves, and includes sections devoted to bronze, iron, cast steel, forged steel valves and accessories. Valve figure numbers are indexed for finger-tip reference by topics: face-to-face dimensions are supplied. Comparison chart offers quick cross reference to commonly used figure numbers of ten valve manufacturers. The Ohio Injector Co.

129 Valve Selection Guide — Featured in 92-pp Catalog 14 is a line of cast and forged steel valves for power, petroleum, chemical, marine, and industrial applications. A visual index shows every valve cataloged, arranged in groups according to type. Other indexes arrange valves by functions and by manufacturer's figure numbers. Photos showing typical applications included, as well as curves and formulas for correlating valve size and pressure drop, condensed rating tables, and cross section views, ASA dimensions, pressure-temperature ratings and ASTM basic materials specifications. Edward Valves, Inc.

130 Quick-Connect Couplings — This 26-pp general catalog on quick-connect, quick-disconnect couplings, shows types for high pressure use, for impact in air lines, for low pressure use, for vacuum and very low pressure applications, and for hard-to-handle fluids. Includes cutaway drawings illustrating construction details, and graphs and tables giving flow and pressure drop data. Snap-Tite, Inc.

131 Steam Traps — This 40-pp engineering manual is designed to assist in the sizing, specifying and selection of steam traps and other fluid specialties. Includes steam trap selection guide, an explanation of the four basic types of traps and how they function, four steps to follow in sizing a steam trap, table of factors and detailed instructions on how to select steam traps for over 45 major classes of equipment. Piping details showing installation method are also included. The V. D. Anderson Co.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

ELECTRICAL

136 Starting Synchronous Motors — Bulletin GER-1520, 10 pp, describes methods of starting various types of synchronous motors. Discusses full-voltage starting, part-winding starting, autotransformer starting, primary resistor starting, primary reactor starting, wye-delta starting and field excitation. A section is devoted to a discussion of synchronous motor operating characteristics affecting control selection. General Electric Co.

137 Substation Transformers — Comprehensive information on transformers used in company's unit substations is given in 12-pp Bulletin 5804. Provides both ratings and construction details on various transformer types available. A section on primary devices — terminal chambers, circuit breakers, interrupter switches and roof bushings — is included. Transformer & Rectifier Div., I-T-E Circuit Breaker Co.

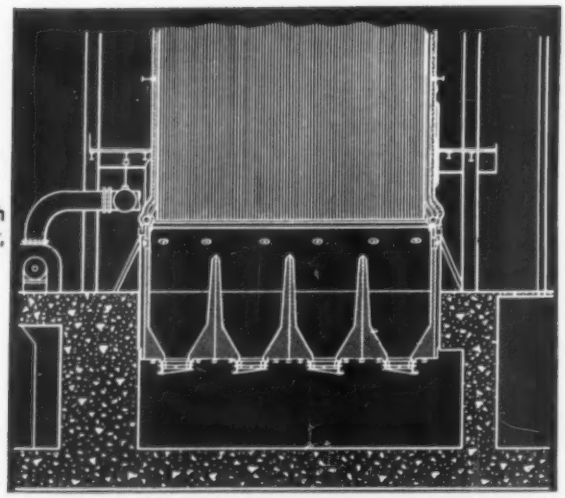
138 Secondary Substations — Detailed information on secondary unit substations — compact load distribution centers for indoor or outdoor applications — is in 24-pp Bulletin 3104-1A. Provides data and specifications on primary devices, transformers, and secondary switchgear offered. Bulletin is divided into three sections covering general information, component dimensions and weights, and electrical characteristics of equipment. I-T-E Circuit Breaker Co.

139 Step Voltage Regulators — Bulletin GEA-5752D, 12-pp, illustrated, describes features and gives application data on company's redesigned single-phase step voltage regulators for pole or station installation. Control diagrams, switching connections, dimensions, and weights are given for 23 ratings from 11.4 to 250 kva in 5 voltage classes. General Electric Co.

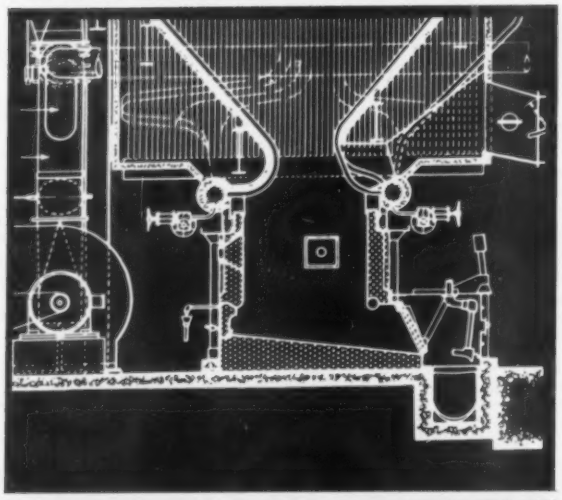
140 Low Voltage Breakers — Bulletin GEA-5915, 20 pp, covers operation and application of low voltage power circuit breakers for circuits up to 600 v a-c and 250 v d-c. Stored energy closing mechanism is one of the many product and safety features described. Also included are equipment and application photos, system diagrams, dimensional drawings, rating tables, guide form specifications, and a listing of available accessories. General Electric Co.

141 Open-Dropout Cutouts — Bulletin GEA-1816L, 8-pp, illustrated, describes design features, application data, ratings and dimensions of company's new open-dropout fuse cutouts, 7.8 and 15 kv, 100 amps. Includes heavy duty rating with expendable cap to interrupt up to 10,000 amps at 7.8 kv and 8,000 amps at 15 kv. General Electric Co.

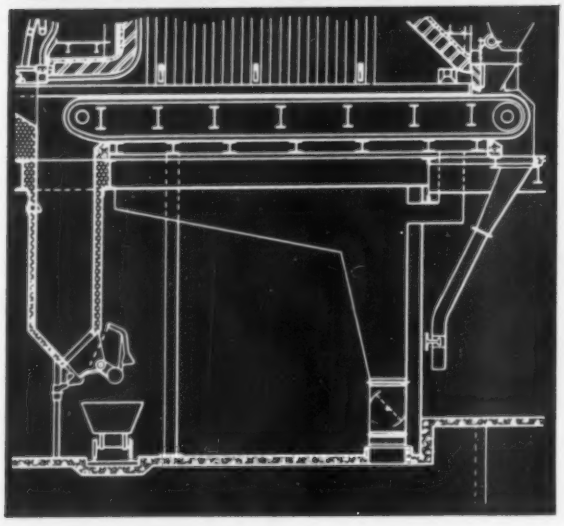
142 Secondary, Service Cable — Bulletin RCP-361, 8 pp, on neutral-sup-



Erosion, due to dry ash sliding down the hopper, is the big problem in this ashpit.



Water jets can cause abrasion of ashpit floor refractories, and water splattered on the walls may cause spalling.



Continuous deposits of ash from a stoker-fired boiler have an abrasive effect on this ashpit lining.

Reduce refractory wear in ashpits with B&W Kaocrete

Relining ashpits is expensive. That's why power engineers specify heavy-duty B&W Kaocrete-D. On job after job, in all types of ashpits, this refractory castable has withstood the heavy abrasive and erosive attacks of sprays, jets, rakes and shovels.

The reason? Specially designed B&W Kaocrete-D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It also saves time because it can be cast or gunned in place.

For the facts and figures on Kaocrete-D, as well as Kaocrete-A which is recommended for less severe applications, consult your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

R605

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS: B&W Ailmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide B&W Ramming Mixes • B&W Kaowool

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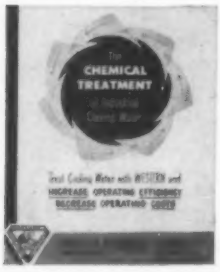
Write Western Today!

For these technical bulletins on

Water, Steam & Fuel Treatment

The Chemical Treatment of Boiler Feed Water. This technical bulletin contains a clear explanation of the causes of boiler water problems and Western's methods of solving them. Special emphasis on scale prevention, corrosion control, sludge dispersion, and suppression of foaming and carry-over.

Steam Plus CORAVOL Equals Protection From Corrosion. This technical bulletin tells how CORAVOL, the original amine process, gives complete protection from corrosion to your entire steam-condensate circuit. Clearly explains the theory of corrosion and the application of volatile amines to steam systems. Cites typical case histories of the use of CORAVOL in various plants and industries.



The Chemical Treatment of Industrial Cooling Water discusses common cooling water problems—scale, corrosion, algae, slime. Also presents Western's proven methods for controlling and preventing these conditions in cooling towers, evaporative condensers, process heat exchangers, engine and compressor jackets, chilled water systems, etc.

Better Fuel Performance and Economy discusses the causes and effects of sludge in fuel oil supplies and soot deposits in combustion areas. Shows how these troubles can be eliminated economically, dependably, and permanently with time-tested special Western formulas.

Also, Technical Bulletins on the chemical treatment of potable and plant water supply—refrigerating brine—sweet water systems. Also, the use of Dry Acid Scale Removers.

WESTERN CHEMICAL COMPANY

Whatever your water, steam or fuel treatment problem may be, you can rely on special Western formulas and individual technical service to solve it dependably and economically.

WESTERN CHEMICAL COMPANY

717 Washington Street Kansas City, Missouri

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ported secondary and service drop cables, provides specifications for both types, including scope of use, conductors, insulation, construction, tests and put ups. Charts show number of strands, insulation thickness, size and type of messengers, current carrying capacity, breaking strength etc. Sag and tension data charts provided. Rome Cable Corp.

143 Electrical Terminals — Continuous strip electrical terminals and attaching machines are featured in this 16-pp catalog. Describes wide variety of strip terminals available and includes a number of dimension charts for easy selection. Kent Mfg. Corp.

144 On Basic Switches — Significant innovations in basic switches for industrial and commercial applications have been added to the new 32-pp edition of this company's basic switch catalog, 62c. New switches described include high precision roller lever switch, adjustable actuator switch, and pulse switch. Generously illustrated, catalog gives application suggestions, other details for over 200 catalog listings of switches and related devices. Micro Switch, Div., Minneapolis-Honeywell Regulator Co.

145 Time Switches — Bulletin GEA-6681, 12-pp, describes in text and pictures company's types TS-40, TS-41 and TS-47 time switches. Includes specifications, pricing, dimensions and ordering instruction, design features, and applications. General Electric Co.

146 High Voltage Contactor — Bulletin 14B7303B describes high voltage air break contactors for control of large motors, primary switching of induction furnace transformers, and other high voltage applications (to 5000 v). Portrays design features of the contactor and includes table of ratings and dimensions. Allis-Chalmers Mfg. Co.

147 Recording Volt-Ammeter — Bulletin GEA-6821, 16 pp, covers portable and switchboard models, a hook-on recording volt-ammeter and an inkless recorder. Describes in text, pictures and tables, applications, features, accessories, ratings and prices. General Electric Co.

COOLING AND AIR CONDITIONING

148 For Economical Cooling — Twelve-pp Catalog S-395 describes features and applications of the Fluid Cooler, an air cooled heat exchanger. Two basic models — vertical or horizontal air flow — are covered, and additional information such as condensed equipment capacity and dimension tables, as well as detailed descriptions of the basic components and accessories, are included in the illustrated catalog. The Trane Co.

Postage-free cards for ordering catalogs are on page 119. You may also use the cards to order literature mentioned in the ads.

149 Packaged Chiller — Described in 6-pp Catalog EM-238 is the Turbopak, a packaged centrifugal water chilling system. In addition to engineering specifications, sizes and weights, catalog provides comparison data on this and other centrif-

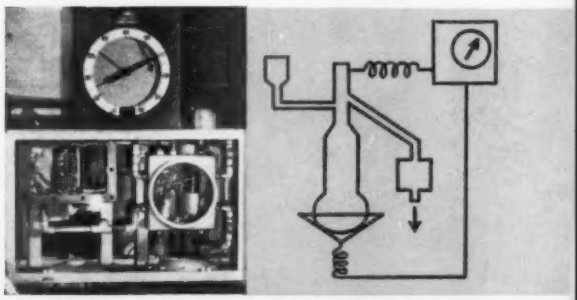
Nothing gets by

Automatic end-point testing device developed by Standard Oil research men makes certain of the uniform quality of gasoline and diesel fuel delivered to you.

Scientists at Standard Oil never stop in their drive to improve and then improve again the uniform quality of the petroleum products that bear the Standard Oil trade-mark. These engineering research scientists have now created wholly new instruments for performing near continuous physical analysis *automatically*.

One such instrument automatically performs the physical analysis that determines end-point. Using it, refineries maintain a continuous inspection of the temperature at which diesel fuels are completely distilled. To you, this means that Standard is able to maintain a constant control over the uniformity and high quality of the fuels you use to power your diesel engines. It also means that Standard Oil power-producing petroleum products, with their constantly controlled end-point, burn uniformly, give you uniform high performance.

This is part of the research pay-out, the "something more" research builds into the products you buy from Standard. This is your return from Standard's investment in research. And now there are 48 district offices in the 15 Midwest and Rocky Mountain states to serve you. Call the one nearest you. **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**



Automatic end-point tester works this way. A small sample is placed in an electrically heated flask. The temperature is measured and recorded during a heating cycle when distillation is accomplished. Distillate is condensed and drained, the flask temperature is lowered by introduction of the next sample, and the apparatus is ready for another test.

You expect more from STANDARD and get it!

If you have TUBES or PIPES from ½" to 12" I.D. you can't clean thoroughly

Try ROTOJET®

Rotojet Tube Cleaners, driven by air, steam or water, are made for straight or curved tubes and pipes from ½" to 12" I.D. Send us your problem.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

For more data, circle 519 on Post Card

ugal systems. Turbopak is for applications from 115 to 350 tons. York Corp.

150 Air Conditioning Unit — Eight-pp Bulletin 870 contains detailed description of components and accessories of company's multi-zone air conditioners, as well as complete capacity and specification data. Construction features are illustrated and described and dimensional diagrams are included. American Air Filter Co., Inc.

OTHER EQUIPMENT

152 Barometric Condensers— Twelve-pp Bulletin 5AA describes barometric condensers for removing air, exhaust steam and other vapors from vacuum equipment. Covers condenser theory, design features, construction, operation and application. Types described include multi-jet; multi-jet spray; multi-spray; and counter-current. Tables give sizes, dimensions and weights, and colored sectional drawings illustrate equipment and explain operation. Schutte and Koerting Co.

153 Anaerobic Digesters— The anaerobic process in sewage and waste treatment is the subject of 12-pp Bulletin 6700. Featuring diagrams and illustrations, discusses methods in treatment of sewage sludge and other organic wastes by digestion, and describes various types of digesters. Infilco Inc.

154 Grating and Treads — Catalog RSL-5, 16-pp, describes open floor grating and stair treads. Features product illustrations of rectangular grating with various wearing surfaces; Relgrit abrasive embedded non-skid grating; U-type grating; radial grating, and other styles of treads. Engineering details, from panel sizes, weights and safe loads, to surface treatments and fastening methods are discussed. Reliance Steel Products Co.

155 Cement Pipe Lining— Twenty-pp catalog describes a process of in-place centrifugal cement lining of pipes from 4 to 144 in. diam. Explains how the process increases pipe carrying capacity, stops leaks in water and sewer lines, prevents corrosion in steel and cast iron pipe, and is applied at a small fraction of the cost of new pipe. Included in the catalog are sample specifications, test results, and case histories. Centriline Corp.

156 Cranes, Hydro Equipment— Twelve-pp Brochure HY-51 describes cranes and equipment for hydroelectric, water supply and other applications. Various components and assemblies that help harness hydroelectric power are pictured, including cranes and hoists, gates and valves, and special hydroelectric equipment. Yuba Consolidated Industries, Inc.

157 Wrought Iron Tubing — Application of cold drawn wrought iron for heat exchanger and condenser tubes is discussed in this 10-pp bulletin. Cites installations in which use of wrought iron and other metal tubing in same equipment permits service life comparisons. Listed are cost-per-foot-per-year figures for each material and corrosive conditions to which tubing was subjected. A. M. Byers Co.

158 Vibratory Handling — Catalog 586 is a 64-pp, pocket-size condensed guide to manufacturer's vibratory bulk materials handling equipment and other products. Those listed include vibrators, packers and jolters, car rappers, hopper level switches, flow control valves, feeders, conveyors, elevators, screens, shakers, heating elements and panels, power tools. In addi-

Look again

At the Milton Roy H20® Controlled Volume Pump

Here's low-cost protection for your boilers . . . Milton Roy H20 controlled volume pumps have capacities ranging from 0.12 to 56 gph, for pressures up to 1100 psi. Both simplex and duplex models are available—for immediate delivery from stock—with stainless steel or cast iron liquid ends.

H20 pumps will give you accurate metering—efficiently and economically—of boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Depend on these pumps for long service life with a minimum of maintenance. And Milton Roy H20 pumps are available in complete packaged systems for boiler feed-water treatment . . . consisting of a steel tank, H20 pump, relief valve and suction piping.

Take a second look at these quality pumps . . . and always look to Milton Roy for assistance in the solution of your most difficult controlled volume pumping problems. Write for detailed information—Bulletin 557—Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives throughout the world.

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • Anders Air and Gas Dryers

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CHEMICAL INSTRUMENTATION SYSTEMS

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PLASTIC PIPE AD WITH NO PICTURE?

Why no picture: Because almost all plastic pipe looks the same. You know yourself that looks can be mighty deceiving, and piping that goes wrong can be mighty expensive. A picture means nothing... but...

There are scores of brands of plastic pipe on the market... made of a dozen different kinds of materials. Most of it is labeled "corrosion-resistant" but the results may be good, bad or indifferent depending on your choice. A picture is no help. Here's what to look for instead:

The universal material? No such thing. No one plastic can handle all liquids and gases... no one has *all* the physical properties required of a truly universal pipe. Closest to it are Ace Riviclor (Rigid PVC) and Ace-Ite (rubber-plastic blend). The former is a little better on chemical resistance, the latter is a little better on impact strength and heat resistance. Both same price.

Are plastics strong enough? Thousands of chemical plants say "yes". Pipe is now available in several wall thicknesses... in flexible tube sizes (Ace-Flex clear transparent), up through gas-tubing sizes (Ace-Ite and Ace Riviclor), through flexible Supplex polyethylene pipe, and Schedules 40 and 80 rigid plastic pipe for pressures up to 490 psi.

Above that, there's Ace rubber-lined steel pipe. And don't forget Ace soft-rubber-lined pipe for resistance to abrasion.

Where do I use it? For corrosive chemicals and gases of all types. The only ones that are difficult are certain solvents and chlorinated aromatic hydrocarbons, and if you're careful to pick the right *one* of the *many* Ace materials, you can even handle most of these tough corrosives. Use plastics, too, for water lines, gas lines, electrical conduit, etc., or any lines where the pipe passes through corrosive vapors or damp areas, or goes underground.

Is there a plastic for hot corrosives? Yes, Ace Tempron, which is good to 275 deg. F. with most chemicals. Stays chemical resistant, strong, and rigid where other plastics may be attacked or may sag.

How can I dodge "trial and error"? Go to a company that has no axe to grind. We, for instance, make no less than nine different kinds of pipe ... with fittings and valves to match... and give you thoroughly unbiased advice backed by 100 years of experience and prices as low as you'll find anywhere.

FREE SELECTOR CHARTS

20 valuable pages...comparable properties, chemical resistance, costs, etc. of 11 plastics and rubber materials Write today for Bulletin CE-50.

AMERICAN HARD RUBBER COMPANY
Division of Amerace Corporation
ACE ROAD · BUTLER, NEW JERSEY

For more data circle 521 on Post Card

tion to product illustrations, and specifications, the catalog illustrates typical installations. Syntron Co.

. . . Outstanding Among This Month's Catalogs

159 Stationary Batteries — Twelve-pp Bulletin GB-1848 is designed to aid in selecting calcium storage batteries for switchgear, alarm system, telephone control, signalling, emergency lighting and other services where batteries are used for standby power. Discusses suggested uses, installation procedures and development of the calcium stationary battery. Tells how to calculate size requirements, and includes engineering specifications. Industrial Div., Gould-National Batteries, Inc.

160 Industrial Insulation — This 18-pp handbook is dedicated to presenting fundamentals of industrial insulation and some of the problems encountered in its application. Cast in question and answer form, catalog also covers special considerations of high temperature insulation and special considerations of low temperature insulation. The Aber Co.

161 How to Bend Conduit — "Making Conduit Bends that Fit" is a little 8-pp manual detailing the steps in fitting rigid conduit or EMT to the job by producing exact stub lengths, back-to-back bends, aligned offsets etc. Tips on the use of modern benders and simple rules for making accurate measurements are provided. Operations are illustrated by simple sketches, measurement diagrams, and tables of shrinkage allowance for saddle bends are included in the manual. The Steelduct Co.

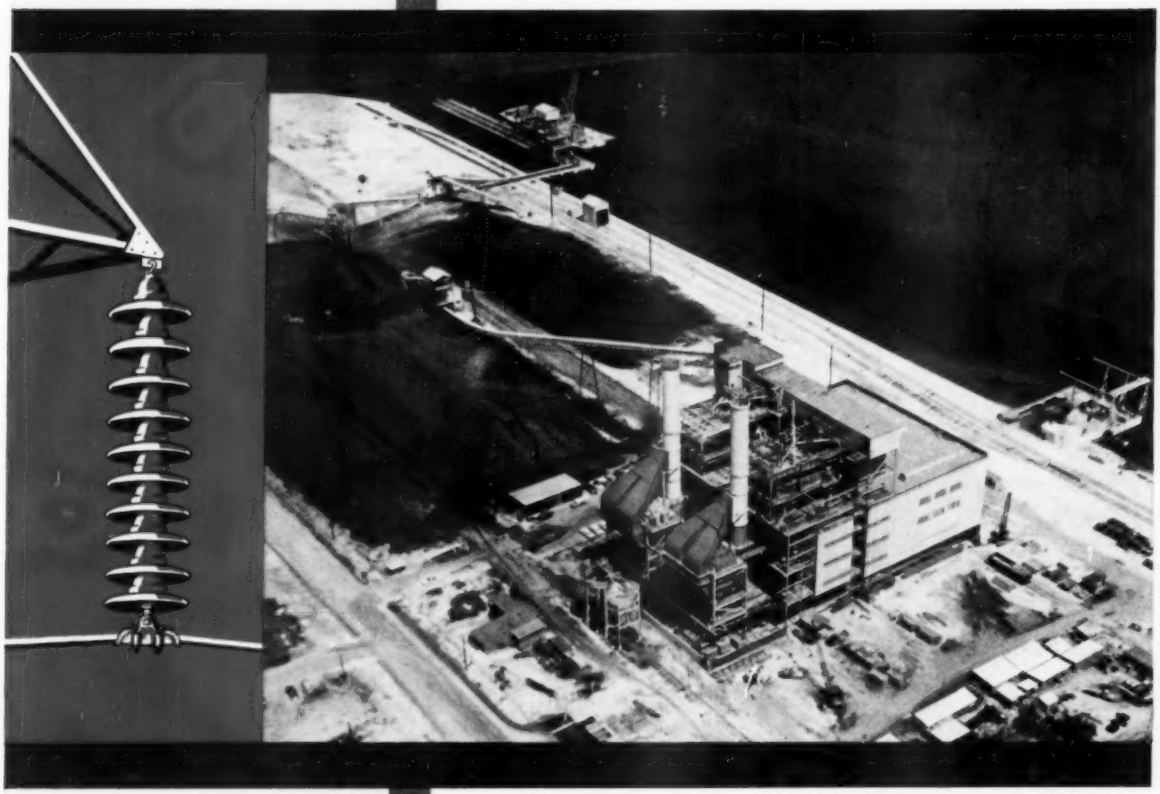
162 Closed Circuit TV — Twelve-pp Bulletin 2239 describes company's major types of industrial television equipment. Gives five basic suggestions for equipment selection, and illustrates each with case histories of successful operations. Diamond Power Specialty Corp.

163 Hard Rubber Fittings — Eight-pp Bulletin PF 1300 describes hard rubber pipe fittings and valves, including natural hard rubber and synthetic rubber. In addition to general information regarding characteristics and handling, folder consists of diagrams and dimensions of threaded fittings, check valves, pet cocks, bibcocks and many types of valves. Luzerne Rubber Co.

164 On Weed Killers — This little 12-pp booklet is a reference guide to weed and brush killers. Discusses several packaged, ready-to-use herbicide formulations for weed and brush control work. Amine salts, regular esters and low volatile esters of 23 specific formulations are summarized. Their particular applications for controlling broad-leaved weeds and clearing brush and woody plants are cited. Diamond Alkali Co.

165. Wire Rope Conveyor — Bulletin 948, on wire rope type belt conveyors, describes advantages of this system of moving materials at low cost. Illustrations show types of carrying idlers, type of rope stands with return idlers and installations. The Jeffrey Mfg. Co.

Engineered for Tampa Electric



Peninsular Florida's first modern coal-fired power station

On land reclaimed from Tampa Bay, Stone & Webster Engineering Corporation has designed and constructed Tampa Electric Company's Gannon Station. Here, following extensive cost comparison studies, coal is being used for the first time in an area previously utilizing oil. Stone & Webster is now at work on Gannon's Unit #3 which, when completed in October, 1960, will bring gross plant capability to 456,000 kw.

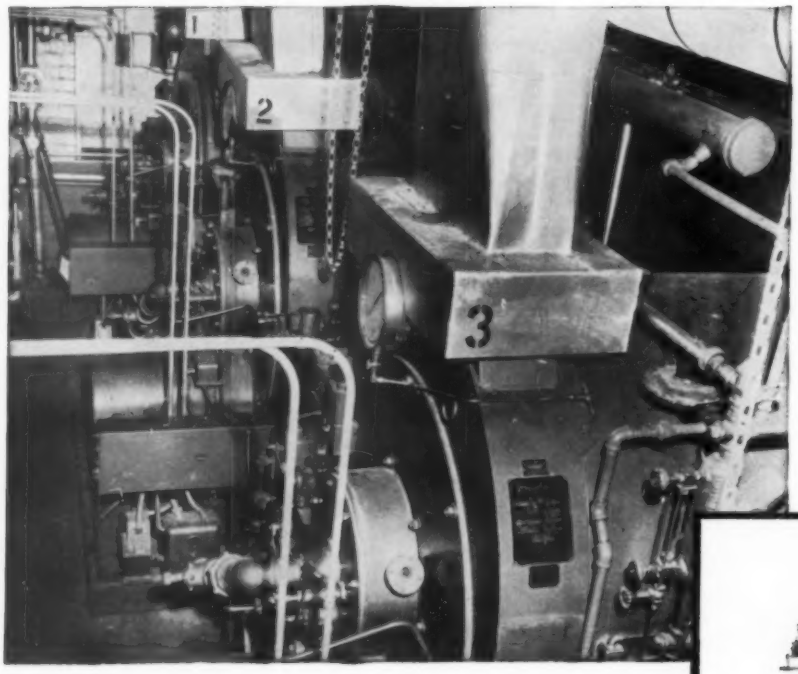
Stone & Webster Engineering Corporation is proud of its world-wide reputation for creating such low installation and operating cost designs — and of its long history of successful engineering in many industrial fields on jobs of varied size and complexity. For help on your next engineering project simply call our nearest office.

Stone & Webster builds installation and operating savings into your project through engineering economies and extra plant efficiency.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

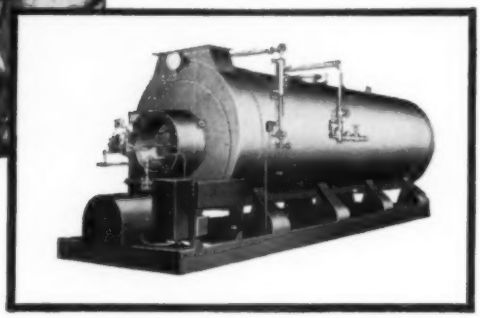


HERCULES-GALION PRODUCTS, Inc., Saves $15,000 Per Year!

Hercules-Galion Products, Inc., of Galion, Ohio, makers of dump truck bodies, ready-mix concrete truck equipment, and steel burial vaults, retired two old style boilers.

To improve heating efficiency, they installed three Cyclotherm 125 h.p. combination light oil/gas package steam generators. The total savings per year comes to $15,000.

As growing production or expanding plant facilities require more steam, Cyclotherms can be added when needed.



CYCLOTHERM

Steam capacity that grows with the plant!

When you recommend Cyclotherm Steam Generators you recommend a steam source that can be quickly and economically expanded to meet plant expansion. For Cyclotherm's wide range of capacities permits the addition of exactly as much new capacity as may be needed at any time. Will 518 lbs. of steam per hr. suit the requirements? That's what a 15 HP Cyclotherm produces. Or are 25,875 more steam lbs. per hour wanted? In that case, a 750 HP Cyclotherm fills the bill. And between these extremes there are sixteen intermediate sizes to choose from.

Compact Cyclotherms are also kind to boiler room space — the Cyclotherm is up to ⅓ smaller than the ordinary package boiler. Installation is easy—no costly stack, no excavation, no foundation. The Cyclotherm is shipped complete — ready to operate. Burner and boiler are built together to work together with *one* manufacturing responsibility back of the entire unit.

Cyclotherm's Cyclonic Combustion guarantees a minimum of 80% efficiency. Larger units operate at from 30% to 100% of rated capacity with no loss of efficiency. Smaller units operate on and off automatically according to load requirements. With simpler design and fewer parts, Cyclotherm reduces maintenance costs by from 30% to 50%. Cyclotherm's world-wide service organization gives prompt service on every call. For full information, write us today.

There are 18 Cyclotherm models, ranging from 15 HP to 750 HP. Burns oil and/or gas. The Cyclotherm meets all state requirements and is built in accordance with A.S.M.E. and National Board Standards and bears the label of Underwriters' Laboratories, Inc. Guaranteed against any defect in materials or workmanship. Cyclotherm also manufactures a complete line of Hot Water Generators in 10 capacities, from 670,000 BTU per hr. to 6,700,000 BTU per hr.

YEARS AHEAD IN STEAM & HOT WATER GENERATION
CYCLOTHERM®
STEAM AND HOT WATER GENERATORS

A Division of National-U.S. Radiator Corp., Oswego, N.Y.

Clip to Your Letterhead

Cyclotherm Division
National-U.S. Radiator Corp.
50 E. First St., Oswego, N. Y.

Please send me your booklet *Cyclotherm Cyclonic Combustion*, also rotogravure copy of *Cyclotherm Sales Steam* with illustrations and descriptions of Cyclotherm installations.

For more data circle 523 on Post Card

Control room at Shippingport Atomic Power Station. Bailey Instruments for the primary system and Bailey Instruments and Controls for the steam system are located on this control panel.

Bailey pioneers the control of . . .

ATOMIC STEAM POWER PLANTS

This control room is the center of operations for the world's first full-scale atomic, electric power plant devoted exclusively to civilian use—the Shippingport Station, jointly owned by Duquesne Light Company and the Atomic Energy Commission.

Here, as well as on the atomic-powered submarines, are Bailey Instruments and Controls performing dependably hour after hour, month after month.

In conventional power plants, too, Bailey Meters and Controls are standard equipment. Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion and automatic control are your assurance of the best possible system.

2. Experience

Bailey engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A136-1

Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

For more data circle 524 on Post Card

Caterpillar

makes tracks for coal

Seven Caterpillar Tractor Co. plants burn coal for low-cost steam generation

When seven plants of a company all burn coal—over 250,000 tons a year—you can be sure there's a *good* reason. At Caterpillar Tractor Co., where steam is used for both process work and heating, coal is burned for low-cost, efficient steam production.

Because of its importance at Caterpillar, steam generation must meet the same standards of efficiency and dependability set up for all phases of plant production. As Caterpillar has expanded from one plant to many, therefore, *each* plant has burned coal.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

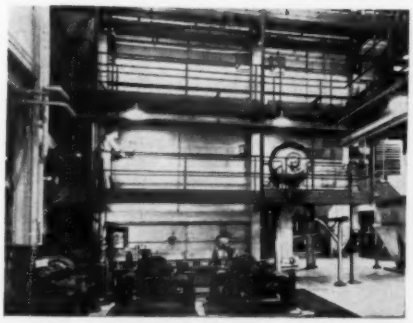
To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send coupon below for our case histories booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

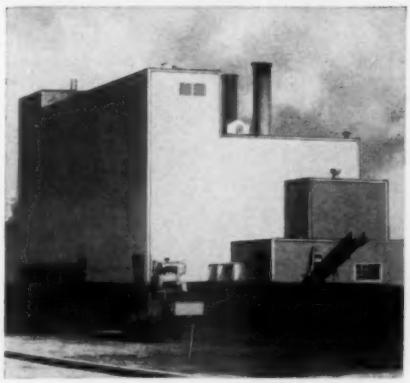
BITUMINOUS COAL INSTITUTE

Department PE-10,
Southern Building • Washington 5, D. C.



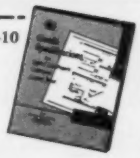
Power house at Morton, Ill. plant uses two 60,000 lb/hr Wickes boilers, 3 stories high. These are equipped with Hoffman continuous ash-discharge spreader stokers.

Track unloading hopper at York plant. Coal feeds from belt conveyor to bucket conveyor to distributing flight conveyor over storage bunker. Coal handling system by Beaumont Birch.



Exterior view of power plant at Joliet, Ill. Foreground shows part of outside coal storage area featuring portable car unloader and stacker. Coal is stocked out and reclaimed by Caterpillar bulldozer-equipped crawler tractor.

SEND COUPON FOR *NEW* "Guide Specifications for Underfeed Stoker Fired Low-Pressure Commercial Heating Plants." Heavy demand for the first edition of this booklet, adaptable for design loads 3,000 to 26,000 EDR steam, has justified an expanded edition covering application of underfeed stokers to firetube, watertube and section cast iron boilers. Complete specification criteria cover all aspects of typical heating plant. PE-10

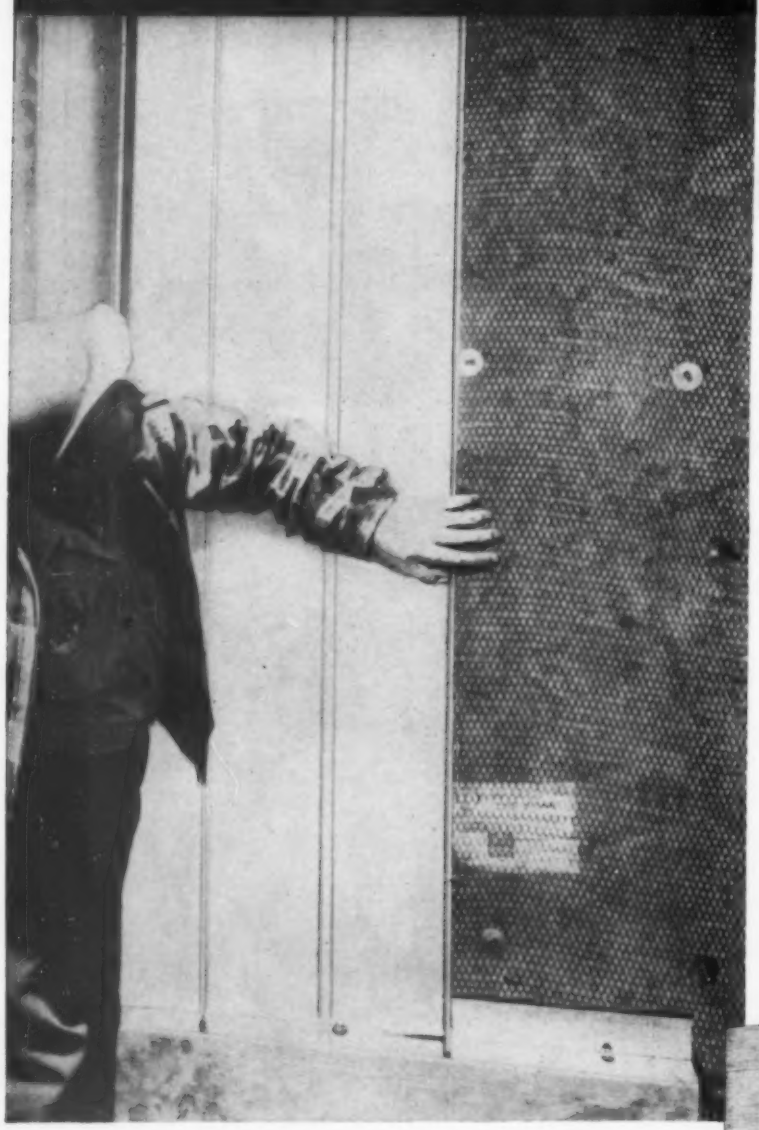


☐ Guide Specifications booklet ☐ Case histories on larger plants

Name.....
Title.....
Company.....
Address.....
City..... Zone..... State.....

For more data circle 525 on Post Card

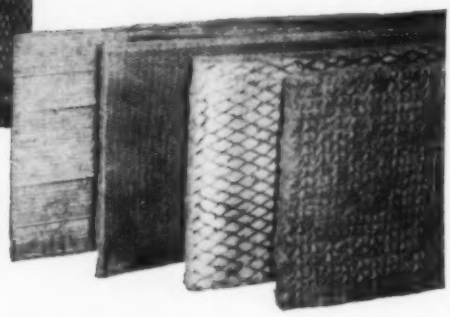
Maximum Efficiency Assured by Containing Heat . . . with 4 inch BALDWIN-HILL *Spun Mineral Fiber* BLANKETS



When Detroit Edison wanted to insulate the boiler water walls of their River Rouge power plant, they selected B-H spun mineral fiber Blankets, 4″ thick, to obtain the required thermal efficiency.

B-H Blankets, size 2′ x 8′, were particularly adaptable to covering the 8′ high areas of the boiler skin casing. These blankets are B-H Style No. 2A with 1″ wire mesh on the inner face and expanded metal lath on the outside. They were impaled over studs welded to the boiler skin casing and laced tightly together to form an unbroken layer of insulation. The blankets were later protected with a shell of aluminized sheet metal panels.

B-H Mono-Block also was used to insulate all heated fan housings as well as air and gas ducts; all joints were pointed with B-H Improved Super Powerhouse Cement.



BALDWIN-HILL *Company*

210 Breunig Ave., Trenton 2, N. J.

Kalamazoo, Mich. . . . Huntington, Ind. . . . Temple, Tex.

For more information on these products as well as other B-H Insulations, write for 1958 catalog—or see it in Sweet's Plant Engineering File.

For more data circle 526 on Post Card

Vogt STEAM GENERATORS

at SUNTIDE REFINING COMPANY

Viola, Texas

Above: Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.

EFFICIENCY AND ECONOMY PROVED BY FIRST 3 UNITS . . . 2 MORE ADDED!

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BPE

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.

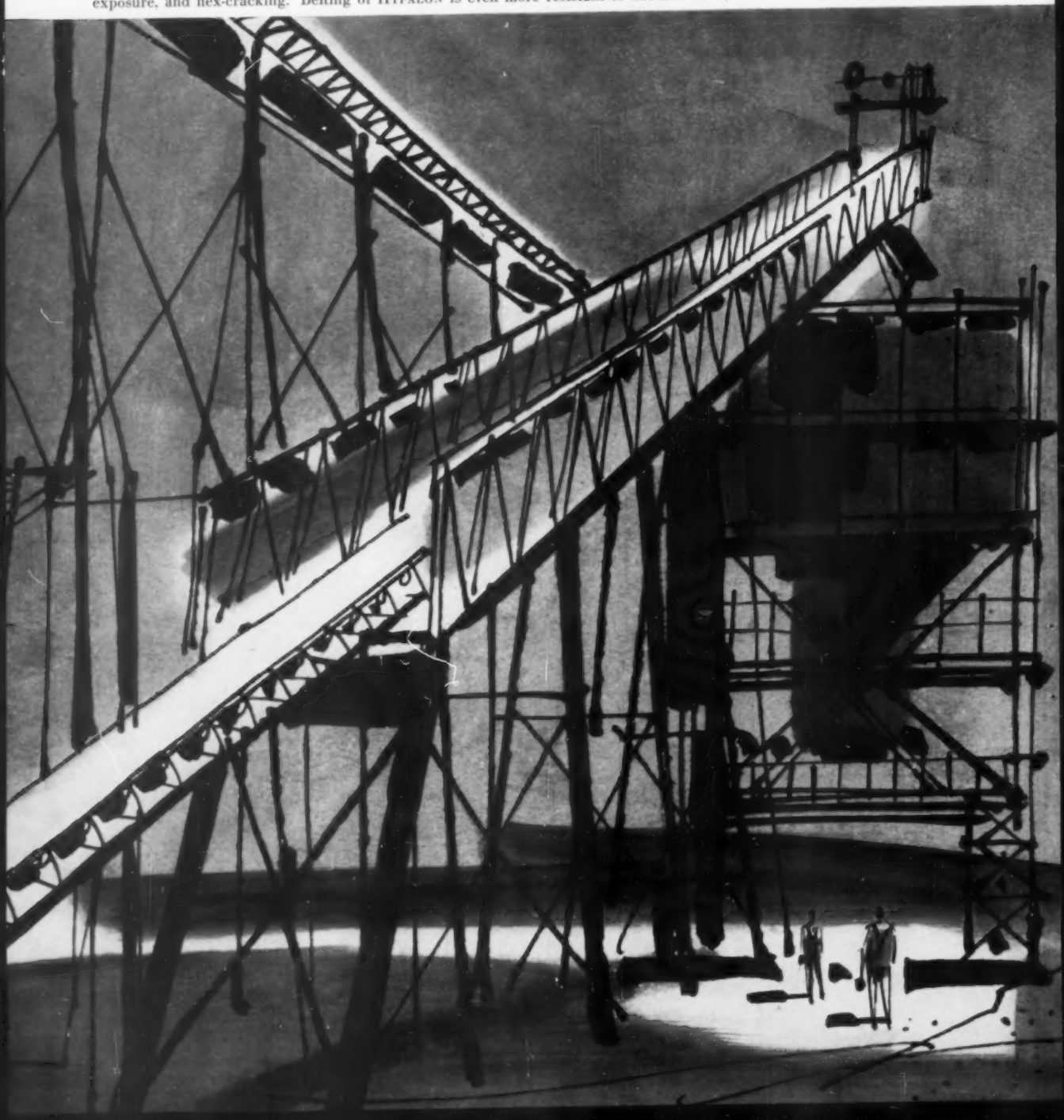
Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

For more data circle 527 on Post Card

How rubber products made with Du Pont

Conveyor belts keep rolling much longer when neoprene protects them against oil-treated coal, grease, abrasion, outdoor exposure, and flex-cracking. Belting of HYPALON is even more resistant to hot materials, abrasion and oxidizing conditions.



neoprene or HYPALON® save money

Extra durability results in longer service life . . . reduced maintenance costs . . . minimum downtime

The drive toward increased operating efficiency in the power industry calls for rubber maintenance products that can withstand higher equipment speeds, higher temperatures, higher pressures, heavier mechanical loads. This is why the extra durability of Du Pont neoprene and HYPALON is more important than ever to long-term economy in conveyor belts, transmission belts, gaskets and hose.

Results speak for themselves. For 17 years, more than 4000 feet of neoprene conveyor belting carried oil-treated coal for a Connecticut power company. Subjected to 400°F. steam, neoprene hose has withstood 3600 test hours. Oil storage tanks gasketed with neoprene are free of any leakage after 9 years. Neoprene resists abrasion, flexing, sunlight, weather, ozone, oil and grease, most chemicals. Nor will it support combustion. Neoprene is outstanding among synthetic rubbers for retaining its properties for long periods of time. Because it combines all these advantages, it is unmatched for durability even under severe service conditions.

Du Pont also manufactures HYPALON, a special-purpose synthetic rubber. It withstands temperatures up to 350°F., resists strong oxidizing chemicals, abrasion, and is unaffected by ozone. HYPALON conveyor belts have been used to carry kiln-dried salt at a temperature of 325°F. HYPALON gaskets are unaffected by ozone.

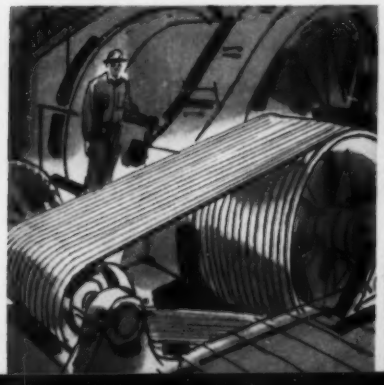
Rubber maintenance products which offer you the long-term economy of neoprene and HYPALON are available now through your local rubber goods distributor. He can suggest the right product for your applications, and offers you quick delivery on either small or large orders. Take advantage of his convenient services by calling him soon. For more information on the properties and uses of neoprene and HYPALON, write for our booklet, *Du Pont Elastomers in Industry*, to: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. PW-10, Wilmington 98, Delaware.

Du Pont synthetic rubbers do more things better . . .
NEOPRENE • HYPALON®

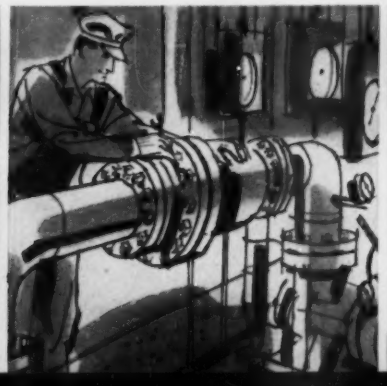
DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

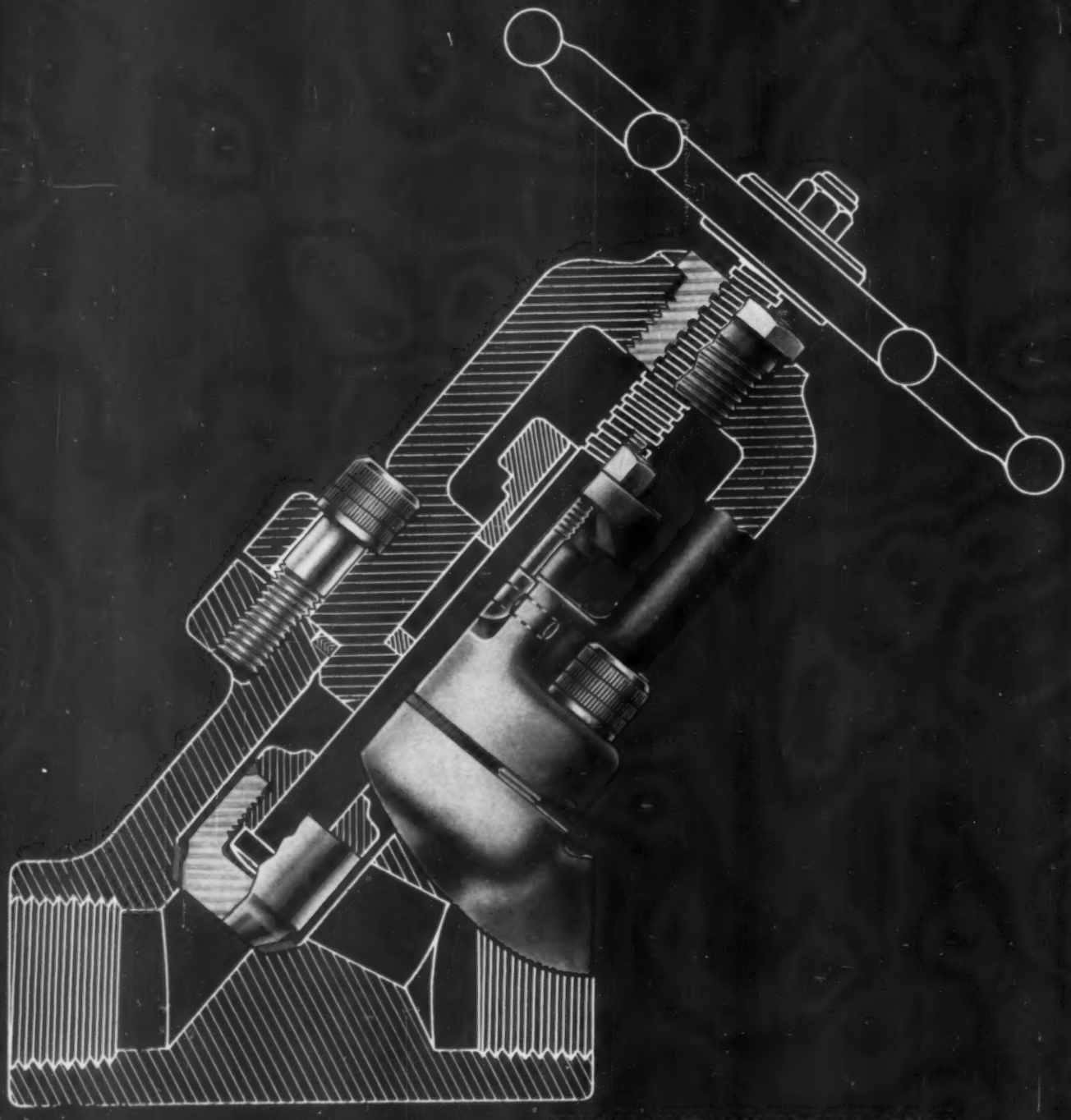
V-belts and other transmission belts of neoprene keep power flowing dependably. They endure shock-loading and high-speed flexing; they resist oil, heat and other tough conditions.



Neoprene gaskets keep joints tight longer due to their combined resistance to compression set and chemical attack. Under extreme conditions, HYPALON gaskets hold up where others fail.



Neoprene hose stays on the job in air and steam service. It resists abrasive particles and traces of chemicals inside, wear and weather outside. It also takes severe flexing in stride.



EDWARD "848" SERIES GLOBE VALVE
(ANGLE TYPE ALSO AVAILABLE)

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Major Improvements at No Extra Cost Mark New "848" Series Forged Steel Stop Valves

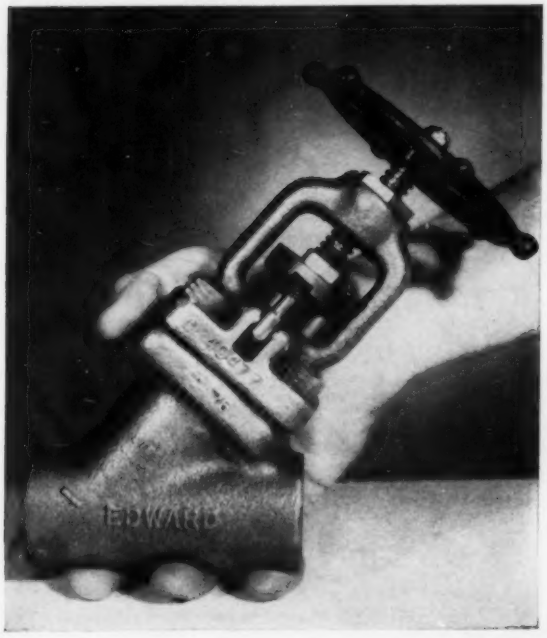
In an industry where any change in design is "news," Edward is proud to introduce a new line of 600-lb forged steel stop valves with so many major design improvements *at no increase in cost.* These Rockwell-built Edward valves are suitable for air, water, oil and other hydrocarbons, anhydrous ammonia and other gases, steam and other non-corrosive fluids.

NEW MATERIALS USED THROUGHOUT

Besides tough drop-forged steel, which is the basis of these valves, Edward introduces such innovations as stainless steel gland bolts, an aluminum-bronze yoke bushing, solid disk of chromium-cobalt-tungsten stainless steel, spiral wound gasket of stainless steel and asbestos, and special alloy cap screws linking body and bonnet.

NEW IMPROVED BODY-BONNET JOINT

Four molybdenum alloy cap screws secure bonnet to valve body. These compact, high-strength cap screws require less space than ordinary nuts and bolts, can be handled with one hand, and deliver maximum compressive force with minimum tightening torque. A new spiral wound gasket, consisting of some 20 turns of stainless steel and asbestos, provides controlled compression not possible with ordinary flat gaskets. Because this spiral wound gasket is free to expand and contract as needed, it "takes up the slack," maintains a leak-proof seal between body and bonnet.



NEW SOLID DISK OF SPECIAL ALLOY

Disk is made of chromium-cobalt-tungsten stainless steel. This new alloy has added resistance to erosion, holds its hardness better under high temperatures than other disk materials. Disk is lock-welded to disk-nut, eliminating wobble and chatter—especially important when valve is called upon for throttling duty.

INTEGRAL STELLITE SEAT FOR LONG LIFE

Valve seat is Stellite—a harder, longer-wearing material with excellent resistance to corrosion, erosion and temperature. Seat is integrally welded to body.

"848" SERIES ROCKWELL-BUILT EDWARD VALVES are available in ¼", ⅜", ½", ¾" and 1" sizes. They are rated at 600 psi—at 910F in carbon steel and at 1030F in chrome-molybdenum steel. Globe or angle types, with screwed or welding ends. Write for facts on performance . . . price . . . and delivery. Address *Edward Valves, Inc., 1200 West 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company.) Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W., Montreal 1, Quebec.

EDWARD STEEL VALVES

another fine product by

ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressure up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

For more data circle 529 on Post Card

SOLID WHEEL

spells non-stop turbine performance

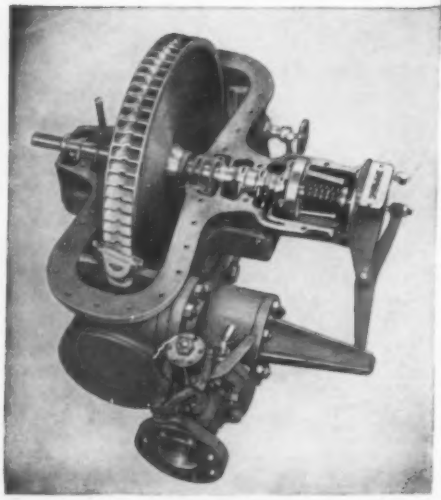
It's easy to see why Terry solid-wheel turbines have been setting non-stop records. They're built for long periods of continuous service.

The rotor, for example, is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out.

What's more, the blades can't foul. There is a one-inch clearance on either side of the wheel and the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

You, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives full details. Send for a copy today.

THE TERRY STEAM TURBINE CO.
Terry Square, Hartford 1, Conn.

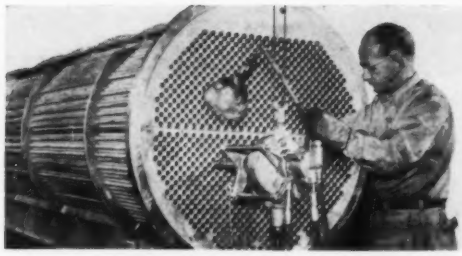


Action of steam in a Terry solid-wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

TT-1205

TERRY

For more data circle 530 on Post Card



CONDENSER AND HEAT EXCHANGER CLINIC

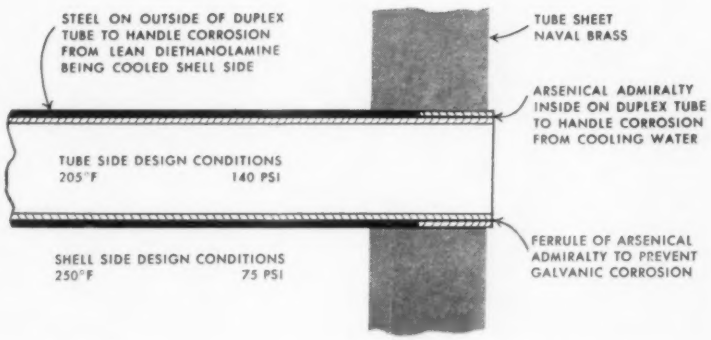
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, N. Y.

Duplex tube applications increase as corrosion and temperature-pressure problems grow more complex

New and improved processes in the chemical and petroleum industries—advancing design in power equipment both ashore and afloat, involving ever higher temperatures and pressures—are calling for more and more duplex tubes.

Working closely with both users and manufacturers of heat-exchange equipment, The American Brass Company is expanding its facilities to provide these special-purpose tubes in the combinations of metals and in the sizes and gages to meet new and growing needs.

Dual corrosion problems. Anaconda Duplex Tubes have been most often used to meet situations involving dual problems of corrosion. They are made by drawing tubes of copper or a copper alloy either inside or outside of steel tubes. However, they can be furnished in any combination of metals, including copper or copper alloys with other nonferrous metals or steel in a wide range of diameters and wall thicknesses.

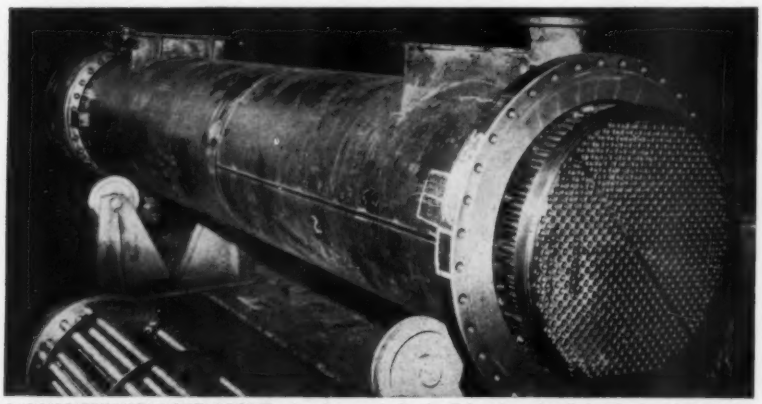

STEEL ON OUTSIDE OF DUPLEX TUBE TO HANDLE CORROSION FROM LEAN DIETHANOLAMINE BEING COOLED SHELL SIDE
TUBE SHEET NAVAL BRASS
ARSENICAL ADMIRALTY INSIDE ON DUPLEX TUBE TO HANDLE CORROSION FROM COOLING WATER
TUBE SIDE DESIGN CONDITIONS
205°F 140 PSI
FERRULE OF ARSENICAL ADMIRALTY TO PREVENT GALVANIC CORROSION
SHELL SIDE DESIGN CONDITIONS
250°F 75 PSI

SKETCH SHOWING CONSTRUCTION of Anaconda Duplex Tubes used in the cooler designed and built by Yuba. Tubes are ¾" O.D. x .065" wall x 16'1⅛" long. The 1/16" thick tube sheets of Anaconda Naval Brass are 31⅝" in diameter and 35⅞" in diameter.

For extra strength. More and more Anaconda Duplex Tubes are being used in those applications where internal or external pressures—or the pressure temperature combinations—are too great for a nonferrous tube alone. In this case the nonferrous tube is selected for the chemical properties required for the more corrosive fluid handled; and the steel tube gives the needed strength.

U-bends. Duplex tubes can be readily bent to form the hairpin or U-bend tubes required for the compact U-bend tube design so advantageous in heat exchangers where wide temperature differences exist in the unit.

Technical Assistance. Specialists at the American Brass Company are constantly working with manufacturers and users of heat-exchange equipment, helping to solve process problems. This experience is available to you. For more detailed information on Duplex Tubes, U-bend Tubes, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.



A LEAN DIETHANOLAMINE COOLER using Anaconda Duplex Tubes (see detail sketch above) designed and built by Yuba Heat Transfer Division of Yuba Consolidated Industries, Inc., Honesdale, Pa. This unit will cool Lean Diethanolamine at the new 19,000 barrels per stream day delayed coker designed, engineered and being constructed for Socony Mobil at Paulsboro, N. J. by The Lummus Company.

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Orville L. Welsh ASST. CHIEF ENGINEER, CONTINENTAL BAKING CO.

"Experience proved to us, Fusetron Fuses could save us money and provide safer protection." . . . *Orville L. Welsh*

ASST. CHIEF ENGINEER
CONTINENTAL BAKING CO.
TOLEDO, OHIO

CASE 1

"A refrigeration compressor of ours was frequently being shutdown because the 60 amp. protection we used just could not hold the starting currents.

"After reading over Fusetron dual-element fuse literature sent to us by our company headquarters, we tried them out with great success. In the past twelve months, we have not had to go near the switch or open its cover.

CASE 2

"In another case, Fusetron fuses saved us a considerable amount of money. We installed 600 ampere Fusetron fuses in parallel in our 1200 ampere entrance switch, rather than using the more expensive mechanical type of protective device.

"Personally, I am confident we now have better protection than we could have had with other types of protective devices."

Here's why FUSETRON dual-element fuses provide safer, more dependable and money-saving protection . . . FUSETRON dual-element fuses provide 10 point protection against electrical troubles. This is unlike circuit breakers or ordinary fuses which, except in rare cases, protect only against short-circuits.

IN ADDITION:

Fusetron fuses require no maintenance or recalibration. They are calibrated at the factory by engineers. Once properly installed, they require no inspection or down-time necessary on mechanically operated devices. There are no hinges, pivots or contacts to stick or get out of order. Dust, corrosion or oxidation cannot increase a Fusetron fuse's capacity or lengthen its blowing time.

After years of inactivity, a Fusetron fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

Fusetron fuses have high interrupting capacity. FUSETRON fuses can safely interrupt severe short-circuit currents and are adequately safe to meet future circuit growth.

Fusetron fuses save on installation costs. Because their long time-lag prevents them from opening needlessly on motor starting currents or other harmless overloads, Fusetron fuses can be installed in sizes to approximate the load current. This protects against waste of space and money by permitting use of proper size switches and panels.

Why Risk Losses! One needless shutdown . . . one lost motor . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing all other types of protective devices throughout the entire installation with Fusetron dual-element fuses.

For Loads above 600 and up to 5,000 amps . . . Use BUSS Hi-Cap Fuses. They have an interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

for more information write for } BULLETIN FIS on Fusetron fuses.
BULLETIN HCS on BUSS Hi-Cap fuses.

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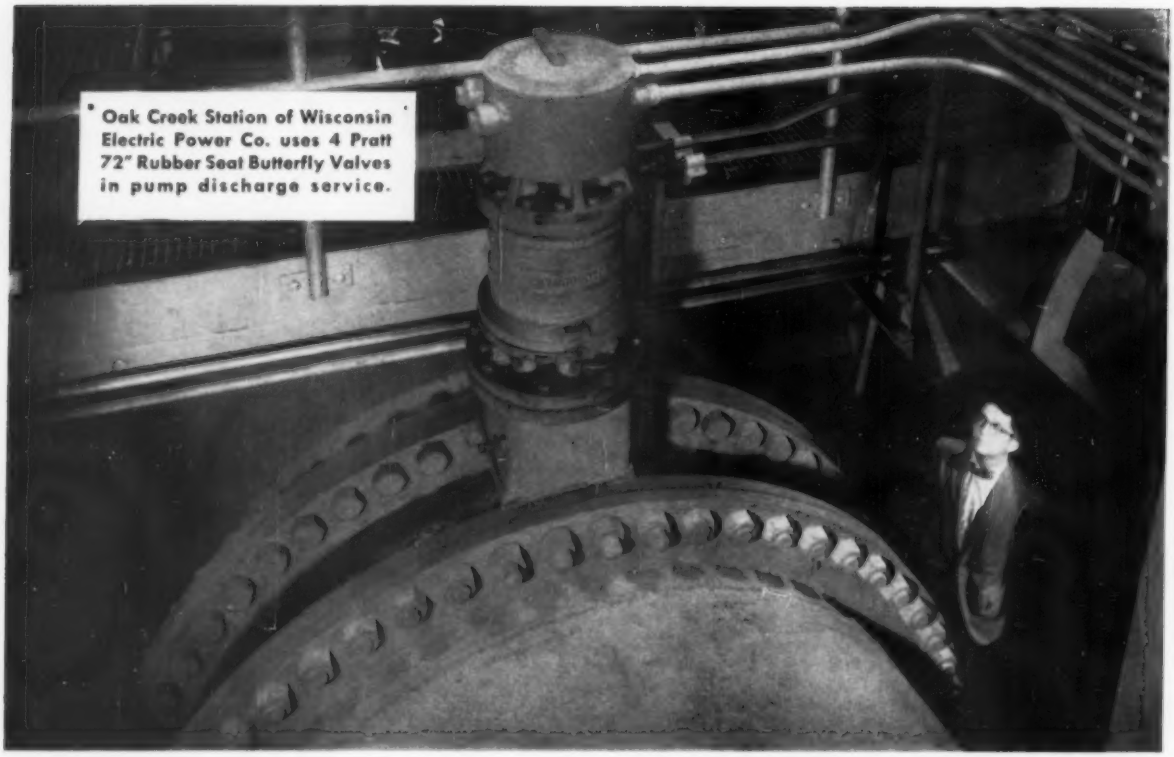
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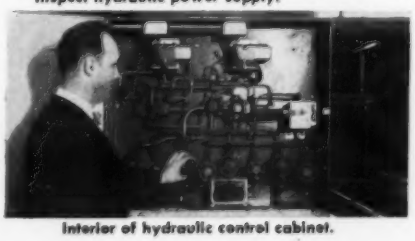

Interior of hydraulic control cabinet.

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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This is a discussion of the safety provisions which have to be built into a nuclear power plant at the present time. Such safety features can be grouped into two categories, i.e., those involving the operational aspects of the plant, and those which have to be provided to protect personnel both within and outside the plant in case of accidents. The latter necessitates the use of some sort of containment structure, and the design of these structures involves the solution of many problems.
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THE CONTAINMENT PROBLEM

THE MOST SERIOUS continuing hazard associated with nuclear power reactors stems from the large amount of radioactive materials they contain. Large reactors may contain hundreds of pounds of radioactive fission products, equivalent to many tons of radium in conventional radioactive measure. True, not all of these fission products are as hazardous as radium, but nearly all of them contribute substantially to the hazard.

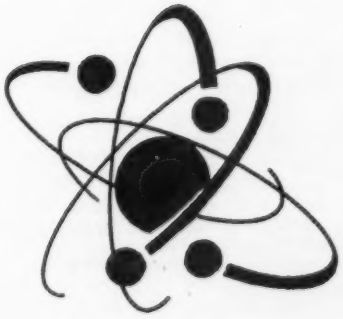
In normal operation, these radioactive materials are completely contained in the reactor system and there is little danger from them. However, the potential ability of a reactor to run away makes it possible for this radioactive material to escape to surrounding areas. While there is no danger of a nuclear reactor exploding in the sense that an atomic bomb explodes, a supercritical excursion may result in a meltdown of reactor components with consequent release of the radioactive material.

Now, it is true that there are dangers associated with the operation of equipment in many different industries. The equipment in a modern high-pressure conventional steam-electric station constitutes a source of danger to personnel, but people working in such plants knowingly and willingly submit themselves to the existing hazards because of salary, special working conditions, or personal interest. To this extent a nuclear plant is not different from a conventional plant, workers understand the hazards and accept them as a necessary part of their lives.

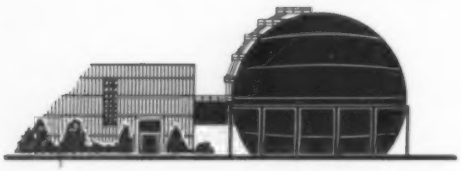
There are, however, moral and ethical problems involved in connection with reactor hazards which are quite different from those in other industries, and this concerns the possible widespread danger to the population surrounding the nuclear plant site. For off-site people, who have no knowledge or interest in the operation of the nuclear plant, it seems that the prevention of danger to their lives or property is a mandatory moral obligation. This public hazard has been one of the main concerns of the Advisory Committee on Reactor Safeguards.

And that is why we have the problem of containment, the method involving the construction of large gas-tight spheres around the reactor to contain the released radioactive material in case of an accident. Such containment, naturally, is expensive and many designers have thought wistfully of how much better off one would be financially if containment could be dispensed with. This however is wrong. As pointed out in the article on nuclear plant safety in the following pages, protection of the public demands that we provide containment and there seems little chance that it can be dispensed with in the reasonable future. The real problem confronting the designer is that of providing the most effective containment at the lowest possible cost. A better understanding of the nature of the hazards offers much opportunity in this direction.

Andrew W. Kramer



Safety Aspects of Nuclear Power Reactors



The necessity for containment continues to be the primary safety problem in the design of nuclear power plants. Studies indicate that the total costs of containment run from 3.5 to 21 per cent of the cost of nuclear plants

THE RECENT criticality accident at the Y-12 Plant in Oak Ridge, in which eight employees received significant exposures to radiation, brings home the fact that the dangers which exist in nuclear establishments, whether for production, power, or research, are of an extremely subtle and mysterious nature — dangers as foreign to our senses as the danger inherent in a high-voltage electrical conductor. As explained on page 54, here was a liquid, perfectly harmless, kept in a number of tanks for storage; yet, when this same liquid was accidentally drained into another tank, it suddenly became a deadly influence throughout a wide area.

This accident occurred in a nuclear materials production plant, but since nuclear power plants utilize similar fissionable materials, it is obvious that the same sort of dangers exist in these plants. These hazards have been recognized from the beginning — ever since nuclear power plants were first conceived — and they have been responsible for all the elaborate and expensive safety provisions incorporated in all nuclear power installations designed and constructed thus far. In general the designs have been ultra-conservative, and it is quite likely that in later years some of the precautions being taken today will prove unnecessary. Because of this situation it is of interest to consider some of the aspects of nuclear power plant safety from both technical and economic viewpoints.

Two Classes of Safeguards

Safety provisions in nuclear plants can be grouped into two distinct classifications. First, certain operational safety provisions must be provided in a nuclear power plant which are not to be found in a conventional type of power plant. Second, certain other safety precautions in a nuclear plant have to be provided to protect personnel both within and outside of the plant in case of accidents. The most obvious example of a special safety precaution is the containment sphere and its excavation and foundations. The only purpose of the containment sphere is to prevent the spread of radioactive material in case of a nuclear accident.

Operational safety precautions involved in the first category include the biological shielding, the control and regulating devices for maintaining the nuclear reaction at the proper level, and the water treating equipment in systems where water is used as the heat exchange medium between the reactor and the power generating equipment. True, regulating equipment and water treatment are necessary in conventional power plants also, but the requirements are much more stringent for this class of equipment in nuclear plants. Despite the similarity in the production of steam in nuclear plants and conventional plants, the operational characteristics of the former type are much more complex, particularly with certain types of systems. For example, in a fossil fuel fired power plant, the process of steam generation in the boiler has no effect on the combustion process, except through the normal combustion-control apparatus. This is not true in a nuclear power system. In such a system, steam production or changes in water density with temperature have a definite effect on the nuclear reaction.

Feedback in Reactor System

In the case of a boiling water nuclear reactor, the steam void content of the water in the reactor definitely affects the nuclear reaction, and this introduces a feedback effect which must be taken into consideration in the design of the system. Thus, in addition to the action of the reactor control rods, which may be likened to the combustion control equipment on an ordinary boiler, in a nuclear plant the physics characteristics of the reactor also have to be considered.

As already indicated, the water treatment problem in a nuclear plant also is much more important in a nuclear plant than in a conventional power system. Whereas the impurity content of the boiler water in a conventional plant is usually measured in parts per million, water in the nuclear plant must be kept at a purity of a few parts per *billion*. Unless the water purity is maintained at this level the heat transfer surfaces may be impaired and thus create a dangerous condition.

Fuel Storage Safety

In addition to the containment sphere, the second category of safety measures involves the storage of spent fuel element under water until their radiation level is low enough to permit their removal for chemical reprocessing. Unless provisions are made to prevent it, it might be possible for operators to stack the fuel elements in such a way as to create a critical mass, and so produce a nuclear chain reaction similar to that which occurred in the Y-12 accident previously mentioned. To prevent this, special under-water racks are provided which will hold only a minimum number of fuel elements and thus prevent the accumulation of a sufficient number to form a critical assembly.

Since these safety provisions in nuclear power plants involve considerable capital investment, serious consideration has been given to possi-

Table I—Itemized operational safety provisions

Neutron and gamma radiation attenuation	Nuclear reaction control	Water treatment
Neutron shield tank	Control rods	Radiation monitoring system
Concrete shielding	Control rod drive	Pressure reducers and heat exchangers
Cooling system for shielding	Instrumentation	Deionizers and filters
		Addl. raw water purification
Cost: $1,600,000	Cost: $2,600,000	Condenser leakage provision
		Cost: $1,900,000
Total cost, operational safety provisions: $6,100,000		

ATOMICS

ble ways in which they might be reduced. At the moment, radiation being what it is, there does not seem to be opportunity for any substantial reduction in the safety measures needed for the normal operation of the plant. Shielding certainly will continue to be necessary in all types of nuclear power plants, though the cost of this will be less with some systems than in others. In the boiling water reactor, shielding is required only around the reactor vessel itself, whereas in the case of pressurized water reactors, shielding is required not only around the reactor, but also around the entire primary water loop, including the secondary steam generators and the primary circulating pumps.

At the Reactor Safety Conference held in New York in December 1957, Kallman and Hanson [1] discussed the costs of the safety provisions typical for a 500 Mw (t) pressurized water plant located in a semi-populous area. These are summarized in Tables I and II. Table I, it will be seen, covers the operational safety provisions, involving a total cost of $6,100,000.

Costs of the special safety precautions, shown in Table II, amount to a total of $8,400,000. In this case, in addition to the containment sphere, a concrete igloo is provided which alone involves an expenditure of $1,200,000. Such an igloo is not necessarily a part of all nuclear power plants. The arrangement is shown in Fig. 1.

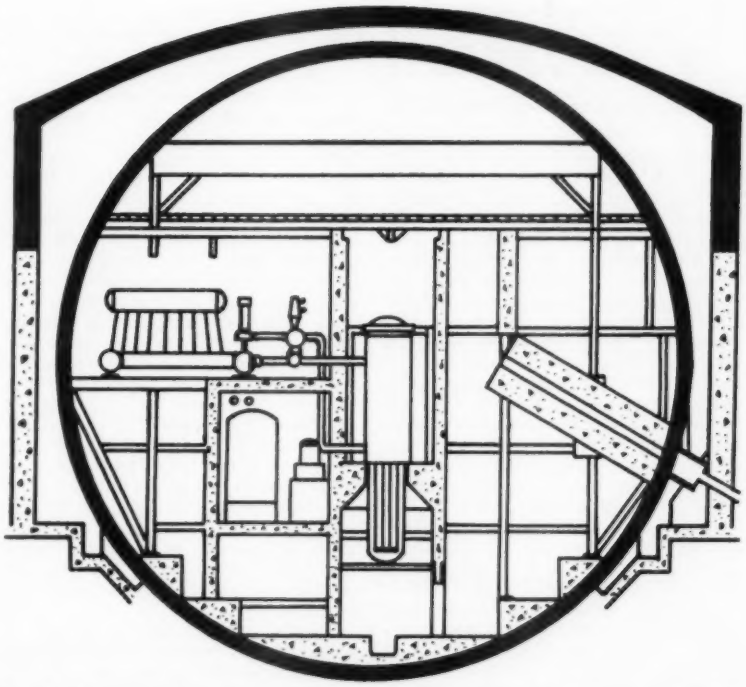


Fig. 1. In some cases, in addition to the containment sphere, a concrete igloo is provided to reduce the radiation hazard

The containment vessel for a nuclear power station is large in comparison with the other equipment making up the power plant. For a pressurized-water reactor the size and thickness of the containment sphere is calculated so that, if the water from the primary system should be released for any reason, the sphere volume and strength will be sufficient to accommodate the expanded steam and gases. The volume of the water in the high pressure loop, therefore, is an important factor in determining the wall thickness and volume of the containment sphere. For example, a primary system which contains 4700 cu ft of water at 1500 psi will, if allowed to expand, call for a sphere of approximately 160 ft in diam with a wall thickness of approximately ⅞ in. This approximation is based upon conservative design, and account has not been taken of some offsetting considerations, such as condensation of a portion of the steam in contact with cooler equipment and walls.

Cost of Spheres

Cost of spheres can be approximated from Fig. 2. For example, a 160-ft diam sphere with ⅞-in. average wall thickness may have an installed cost of around $1,500,000. This cost is for the bare steel sphere and bracing only and does not include reinforced openings and penetrations, testing, and optional additional costs.

In addition to the bare sphere itself, excavation is needed and there are further costs for the foundations and the structural steel necessary for the support of the sphere. A cooling system is required for the removal of heat from the process equipment and a ventilating system, with quick-closing dampers may be needed to provide some change of atmosphere within the sphere. A spray system may be installed to condense radioactive steam in case of an emergency, and finally, a pressure-regulating system will be needed to make certain that the sealed containment vessel is never under excessive external pressure. As shown in Table II, an order of magnitude estimate for these items, including the sphere itself, for this typical case, is $3,800,000.

Special safety precautions may include certain systems of an auxiliary nature, systems which will probably not be called upon during normal operation but which are reserved for use in combating possible unusual circumstances. For example, extra auxiliary and emergency power supplies, over and above that which might be found in a conventional plant, may be desirable to insure that power will not be lost completely to the primary coolant circulating pumps. A small decay cooling system with low head pumps may be provided so that the temperature of the fuel elements may be controlled when the primary system is opened. An approximate cost for these and other auxiliary provisions, for the 500 Mw case, is $1,400,000.

The transmission line item in the third column of Table II refers to the cost of longer transmission lines that may be needed where a nuclear power station is located in a remote area. Most conventionally-fueled power plants are located as close as practical to the center of density of the load. However, most of the larger nuclear power plants are planned for sites at greater distances from load centers. The investment cost of longer transmission lines in rural areas increases in a straight-line relationship with the distance between the supply and the load center. If this incremental distance, which may be selected for safety precaution reasons alone, should be only 30 miles, the additional cost for longer transmission lines may amount to from 2 to 4 million dollars.

Building Costs

As pointed out by Kallman and Hanson in their paper, though the containment sphere would seem to be a fairly expensive precaution to take, to guard against an accident that may never occur, it is of interest to consider the cost of a typical building that might be constructed above the reactor equipment if the containment structure were not needed. Taking into account the excavations and foundations that would be needed

for this typical reactor building, it is estimated that the cost of such a building might amount to $3,000,000. Thus, in summarizing the economic aspects of reactor safety, the $6,-100,000 cost for the operational safety features and the $8,400,000 cost of the special safety equipment are not additive. Offsetting the $8,400,000 for special safety, it is desirable to give consideration to the cost of a typical building equivalent to the containment sphere — $3,000,000. Thus, the net extra cost for the special safety equipment, taking into account the deduction for the typical building, may be $10 to $35 per kw. This is not a major factor in the planning for a commercial nuclear power plant.

Reactor Containment Problems

This analysis of the cost of containment does not imply that the problems involved in containment have all been solved. As pointed out by R. O. Brittan [2] of Argonne National Laboratory, at the same Reactor Safety Conference at which Kallman and Hanson presented their paper, the real interesting economic question should not be, "How much does containment cost?" but rather, "Which of several alternate containment proposals cost the least?" Studies of a number of reactors gave widely varying costs for containment. Such a comparison, however, involving only power reactors, was spotty, primarily because over the years the containment features which had been adopted were vastly different. The costs in terms of per cent of total plant costs varied from 3.5 to 21 per cent for all criteria and all capacities.

Because of the varying criteria, the only correlating trend was low percentage for largest installed capacities, to high percentage for smallest installed capacities. Plants employing extremely tough containment criteria involving both high order explosions and provisions for expansion of coolant, of which EBWR is an example, show a much higher percentage range than those which are designed only for coolant flashing or coolant burning. Several years ago our ignorance of availability of loading for the enclosure was extreme. The practice was to set theoretical upper limits on the pertinent energy sources — nuclear, chemical, and stored thermal — assuming that all this energy was suddenly available and that it all went to increase the temperature and pressure within the enclosure. For the most interesting reactors such an approach led to structures nearly impossible to construct or to finance. In addition, it was assumed that various components of the primary system (top plugs, shields, pipes, control rods, etc) were hurled as supersonic missiles at the poor envelope. Since then several refinements in analysis, new considerations, and reductions in ignorance have lowered the theoretically available energy figures by perhaps an order of magnitude. At present we are in a position to predict that most systems are containable through reasonable provisions.

If the nuclear energy release is added to the chemical energy release of a metal-water or metal-air reaction and to the stored energy release of the high pressure, high temperature water, one arrives at a figure of several times 10^{10} cal for the possible energy release of the system, with the nuclear energy being a small fraction of the total. Our background experience has allowed us to assess availability of energy for damage only on the basis of damage by high explosives. However, as Mr. Brittan pointed out in discussing this method of damage evaluation, it is very misleading. If one assumes that 1000 cal is the energy equivalent of 1 gram of, say, TNT and attempts to design containment against high energy blast, one is faced with containing the explosion of what would be several tons of TNT, a very formidable task. We may as well shoot at trying to contain a 1-kt atom bomb explosion.

Damage to Barrier

Fortunately, for people trying to provide containment there are two additional conditions to be considered in deciding what energy is available for damage to the barrier (the containment shell); these are time and mass. The latter condition arises as an adjunct to power reactors necessarily present because of considerations other than containment, namely the biological shielding, containment of the working fluid and plant requirements. The necessary presence of mass to provide shielding affords a means of reducing drastically the energy available to wreck the envelope, and a means of working with the other condition — time — to allow conversion of the work to harmless stored energy as heat. The importance of the time factor can best be shown by assuming that the energy release is very slow and has time to spread nearly uniformly through the available mass of material, in which it is stored as heat. In most useful systems which Mr. Brittan had examined, such storage of the energy in the reactor and primary structures, including shielding, when accomplished slowly, has no manifestation other than a few degrees temperature rise and a slight expansion. Even the worst cases examined appear to be several orders of magnitude slower than for the explosive. One of the currently important missions of people working on containment, said Brittan, is to erase, once and for all, the word TNT from the vernacular. In speaking of the energy releases one must specify magnitude and rate of release.

The picture is currently being made more satisfactory by examining means of attenuating the energy density within the confines of the shield. The attempt is to reduce the rate of energy transport and stretch out the time scale to allow bringing into play various means of providing energy sinks. Actual expansion of the core materials, for example, whether it be fuel elements or coolant, can be arrested by energy removal through conduction of heat to the materials of whatever energy sink may naturally exist or be provided. The vapors of flashing pressurized water can be condensed in a large water reservoir if enough time is available.

There is little possibility of a shock wave being transmitted to the air between the primary structure and the outer container at the shield interface. A shock loading to the outer shell then is not considered in design. At best, only a sudden pressure rise to a calculable maximum can be expected, with a pressure-time relation depending on the exit time of the core materials and flashing or burning times.

Some thought should be given to the possibility of missiles penetrating the outer shell. It is conceivable that control rods or pipes might be shot out of the primary structure. Such objects having a large ratio of mass to impinging cross-section could penetrate. Studies to date indicate that in the expected velocity range and for probable shell thicknesses, there is a

Table II—Special safety equipment

Ways to prevent radioactive gas leakage	Sky shine control	Extra equipment *
Containment sphere Excavation Foundation Structural steel Containment cooling system Ventilation system Spray system Containment pressurizing system Cost: $3,800,000	Concrete igloo around sphere Cost: $1,200,000	Auxiliary power supplies Decay cooling Emergency poison injection system Instrumentation channels Other special items Transmission lines Cost: $3,400,000 †
Total cost, special safety equipment: $8,400,000		

* Auxiliary nature.
† Estimated $2,000,000 included for transmission lines cost.

high probability, but fortunately the possible numbers of such missiles is small, so that provisions can be made to eliminate them in design or guard specifically against their action by missile stoppers existing in our experience, woven mats for example. A more remote worry is the possibility of penetration from without by a missile such as an aircraft which would destroy the outer barrier and affect the primary system to the point of precipitating an internal accident.

To eliminate such an accident it will be necessary to prove that the penetrating missile cannot cause an internal accident. If this can be done, no one will argue with the contention that penetration by an external source cannot occur simultaneously or nearly so with a reactor accident.

Once the architect-engineer has the time dependent loading information it is straightforward to design the outer shell, including penetrations necessary for operation and servicing. From this stage, however, a whole new class of problems arise in the battle to prevent breaching. These are characterized by such items as control of construction, initial and continuing proof testing, and criteria for allowable leakage. In many instances it will be found necessary to specify shell thicknesses of over an inch. It seems that fabrication techniques are not economically available if the thicknesses get much greater than about 1¼ in. It will be noted from Fig. 2 that thicknesses of 1½ in. are required to meet certain conditions. Control of weld quality and satisfactory rework of substandard welds can be a real headache on thicker structures. Present construction practice generally requires use of certified welders, X-ray inspection of all welds, and soap bubble tests. But all controls applied during construction and post-construction inspections are not quite reassuring enough. A final proof of containment is necessary.

Leak Rates

Codes at present call for a pressure test 25 per cent above design loads. While this test proves the strength of the vessel (it does not burst) the measurement of leak rates is another problem. There is currently no criterion which specifies allowable leak rates. Most of the test methods adopted can show only that the leak rate is less than about 1 per cent per day, and takes considerable time. Studies of consequences of reactor accidents show that protection of the public is not adequate at leak rates of 1 per cent per day for reactors in the large power reactor class. The leak rates may actually be lower than 0.01 per cent per day, but the tests are not accurate enough to prove this. Furthermore, initial testing takes care of *now*, but how about *tomorrow*, and the next day, and the next? Practically nothing has been done about periodic checks which will demonstrate continuing reliability of containment in the years to come — 5 years, 20 years, even 50 years ahead. The use of repetitive tests of the initial type seems out of the question. Downtimes and damage to pressure sensitive controls are deterrents. Yet, further penetration may be found necessary, and old ones may go bad. These must be detectable with a nondangerous test, or the props are knocked out from under the foundation of the containment provision.

So, since the problem of containment is with us, it is necessary to look at the cost, not, as previously indicated, what does containment cost, but rather, which of several alternate containment proposals cost the least. As already mentioned, cost studies at Argonne showed containment costs varying from 3.5 to 21 per cent of the total plant costs. For two reactors of a given type and using equivalent criteria of design, the ratio of containment costs may go up by a factor of 2 or 3 as the installed capacity ratio goes up by a factor of 10.

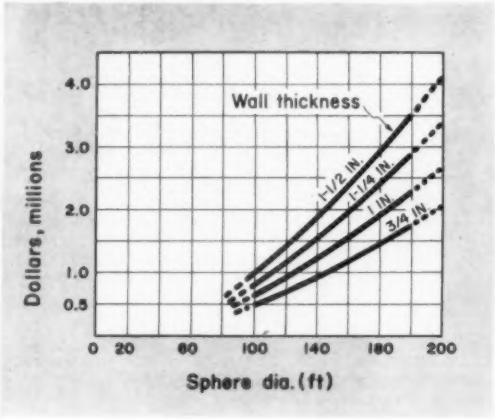


Fig. 2. Approximate cost of containment spheres

A study was made by Sargent & Lundy of Chicago for Argonne National Laboratory of two boiling water reactor plants, each with and without containment criteria and for several arrangements. The small one was a 20 Mw (t) job, the other larger by a factor of 30. The small one showed 17.5 per cent for containment, whereas the larger one showed about 7 per cent for containment on the basis of total plant cost without containment. On a unit power basis, the smaller plant showed $40 per kw (heat) for containment, the larger one $6.5 per kw.

The Future of Containment

For the present, and no doubt for a long time in the future, containment is with us, and it is useless to think wistfully of how much better off one would be financially with no containment. It should be looked upon as insurance. As Mr. Brittan said in his discussion of this subject at the Reactor Safety Meeting, it probably would be impossible to buy insurance for a power plant without containment provisions. So what can be done about the problems which containment involves? First of all, ad hoc projects must suffer along on their own hook, doing the best that can be done with the knowledge available now. For the future, one of the first things to work toward is the establishment of realistic criteria which may be used as a guide in containment design on a uniform basis. Studies may be undertaken to establish possible leak rates on the basis of maximum permissible emergency doses. This will allow proper leeway on the basis of operating power level. It seems clear that a 20-Mw reactor plant safely leaks at a greater rate than a 200 Mw reactor plant if any leakage at all is allowable. Work must also be done on the problem of proving containment, i.e., leak rates, both initially and on a continuing basis. Next, a new and separate code and set of specifications for design and construction of an unfired vessel with a one-in-a-lifetime loading should be prepared. Use of codes for continuously loaded vessels imposes unjustified penalties on design.

Use of Energy Sinks

Expansion of the experience on missile penetration and protection to take care of the low velocity range also seems a likely candidate for work, and the development of information which can be used to place upper limits on peaks of pressure waves near the outside of the shield must be undertaken. This will disclose whether special efforts must be made to design further for attenuation of the energy density. Methods of utilizing energy sinks to cut down on flashing, means of quenching fires, and venting schemes can be studied.

ATOMICS

Some of the biggest factors of ignorance can be materially reduced by fostering further attacks on the problems of mode, rates, and efficiency of energy release, including nuclear, chemical, and stored. Along with this, we must look for a better understanding of the physical changes taking place within the core. All these relate the three types of release on a time scale. Intermingled with this can be studies to enable a better understanding of the energy division between malignant and benign forms.

A further task is that of increasing our experience on damage evaluation for the energy release rates encountered, and this means finding equivalent sources for experimental simulation in both time and magnitude. Coupled with this must be a real attempt to prove lack of or determine extent of scale-effect so that fractional scale model tests can be used. Economy demands this.

These, then, are some of the problems concerned with reactor safety. As is obvious, containment constitutes the greatest single factor, and there seem little likelihood that this will not remain an important factor for a long time to come. If some means could be developed which would make a nuclear accident impossible, then perhaps the need for containment could be eliminated. Only recently has come the announcement of the successful development of a reactor safety "fuse," an idea that has been thought of and worked on for a long time. This particular fuse, developed by Atomics International for the AEC, is designed to provide absolute protection by shutting down "pool" type research reactors without the use of external controls should an abnormal operating condition occur. If such a fuse can really be made foolproof — if it could be made to provide *absolute* protection, then perhaps we could begin to think of doing away with the containment structures which today must enclose all our power reactors. Some day also we may develop a fusion power reactor and then the need for containment will disappear.

References

[1] Some Economic Aspects of Reactor Safety. D. Kallman, The Babcock & Wilcox Co and O. G. Hanson, The Consolidated Edison Co.

[2] Reactor Containment Problems. R. O. Brittan, Argonne National Laboratory

The Y-12 Radiation Accident at Oak Ridge

ON JUNE 16, at 2:05 p.m., an accident occurred at the Y-12 Plant in Oak Ridge which exposed eight employees to significant amounts of radiation, fortunately, however, without serious consequences. Of the eight men exposed, three did not receive a sufficient dose to require prolonged hospital care. The other five showed significant decreases in blood elements and other symptoms characteristic of more severe, but not lethal, radiation damage and, therefore, were hospitalized for a period of approximately six weeks.

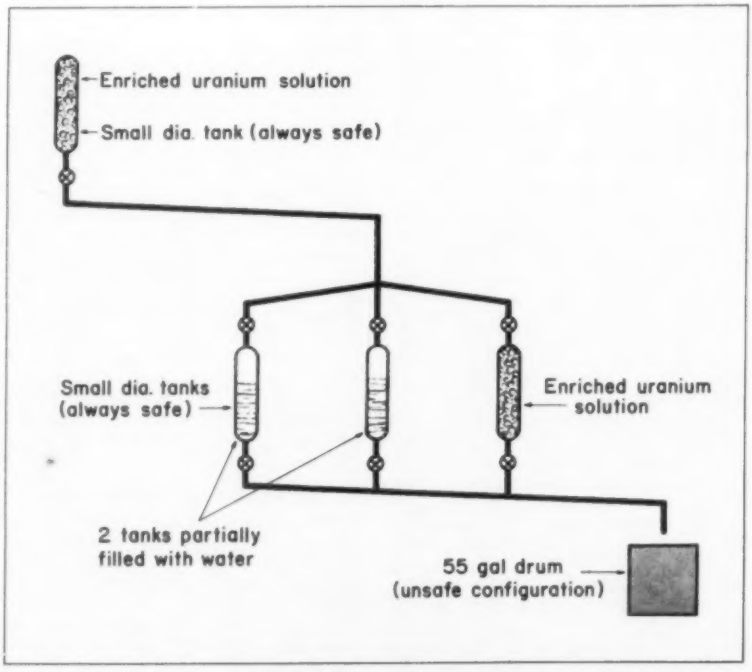
The accidental nuclear radiation resulted from the unexpected formation of a critical mass while handling a solution of enriched uranium. This reaction took place in a 55-gal stainless steel drum in an enriched uranium recovery area in the Y-12 Plant. The recovery area is located in a wing of one of the large buildings.

On the basis of presently available information, the following sequence of events led to the nuclear accident: A portion of a highly enriched uranium bearing solution leaked or otherwise flowed through a valved pipeline from a small diameter tank in one wing of the building to another small diameter tank in the recovery area. The solution also filled the piping which connects the first tank with two other small diameter tanks in the area. All of the tanks, because of their geometrical configuration, were of the *always safe* type and a nuclear reaction could not occur even though the tanks were filled with enriched uranium solution. Insofar as can be determined from the verbal description released by the AEC, the arrangement of tanks and piping was somewhat as shown in the accompanying diagram. This arrangement, however, may, or may not, be correct.

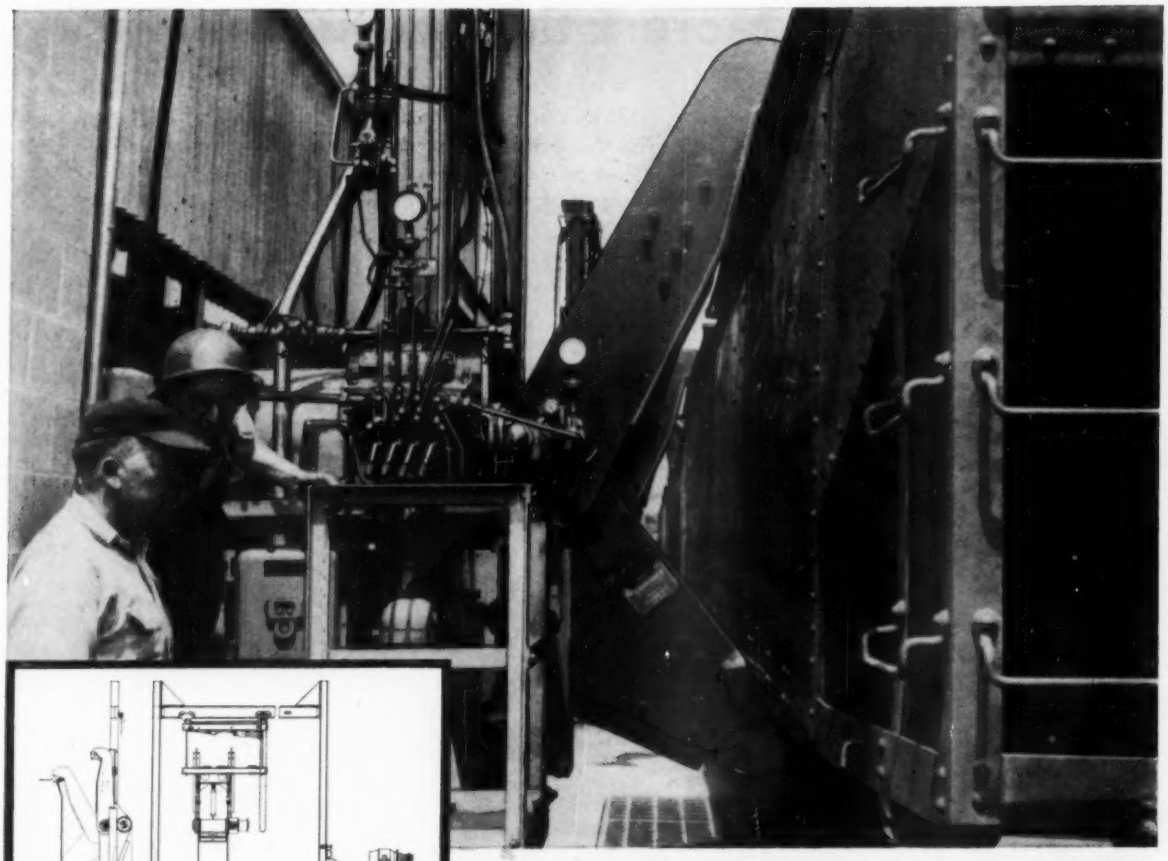
Subsequent to this inadvertent transfer of enriched uranium, two of the three tanks in the recovery area were partially filled with water for routine leak testing following a monthly clean-out for inventory. During this operation, an employee, unaware that enriched uranium had leaked or flowed into the tank and piping, drained the solution into a 55-gal drum. As the valve on the drain line was opened, the enriched uranium solution in the tank nearest the valve preceded the water into the drum.

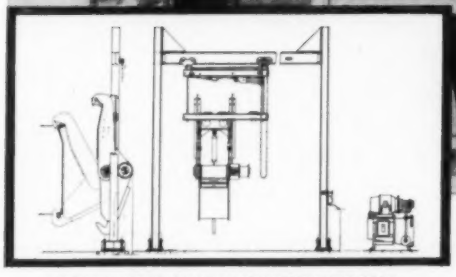
The enriched uranium in the drum was then in a non-safe configuration and a nuclear chain reaction occurred. Although there was no explosion, there was an instantaneous emission of radiation.

Following the initial emission of radiation and upon water dilution, the material in the drum is believed to have pulsed in periodic emissions of radiation for a period not exceeding


Enriched uranium solution
Small dia. tank (always safe)
Small dia. tanks (always safe)
Enriched uranium solution
2 tanks partially filled with water
55 gal drum (unsafe configuration)

General arrangement of tanks for storing and handling radioactive solutions at the Y-12 plant





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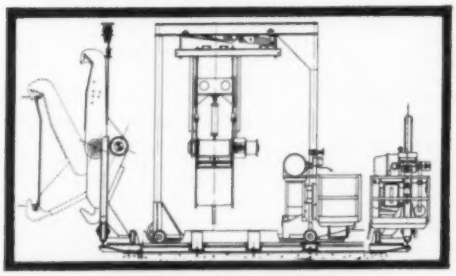

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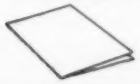

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four minutes. The initial emission of radiation activated the plant alarm system and plant emergency procedures were put into effect. Personnel evacuated the buildings and the main road to the plant was closed to traffic.

Radiation control specialists were brought in from other portions of the plant and other Commission plants in Oak Ridge to determine the source of the radiation.

Eight employees were in the vicinity of the drum at the time of the incident. All of them were carrying out routine plant operations and maintenance. One employee, a chemical operator, was participating in the leak testing which inadvertently set off the reaction. He was within three to six feet of the drum when the incident occurred. The other seven were from 15 to 50 feet away at the time. Two were engaged in installing ductwork; two electricians were engaged in removing conduit; two others, a welder and a machinist, were located on a mezzanine near the scene of the incident; and the seventh, a chemical operator, was starting up an evaporator some 50 feet away.

Two of the men reported seeing a a blue flash at the time the reaction occurred, and some of the men reported a strange sweet smell in the air. They all evacuated the area quickly upon hearing the radiation alarm sound.

Since the determination of radiation exposure from a reaction of this type is complicated under any circumstances, special methods were used to determine the neutron and gamma exposure of the individuals nearby.

These methods included readings from indium foil which is incorporated in all Y-12 security badges; determining the radioactivity of sodium-24 in the bodies of those exposed through whole body and blood counting; and by measurements obtained through a mock-up of the accident. The latter series of experiments was conducted by the Oak Ridge National Laboratory on June 17 and 18.

Through use of these methods, it was estimated that the eight men received radiation exposures ranging from a high of 320 rad to a low of 20 rad.

Three of the men who received the lowest exposure were released from the hospital on June 26. Five others who received higher exposures remained at the Medical Division Hospital of the Oak Ridge Institute of Nuclear Studies where they underwent further observation and tests. All five, however, were released from the hospital on July 30 but will return for periodic checkups.

ATOMICS

More Efficient Nuclear Plants for Britain

Studies by British scientists on the possible use of beryllium oxide and other highly refractory materials as moderators may lead to the development of high temperature power reactors considerably more efficient than the Calder Hall variety

By R. M. FISHENDEN
Head of Scientific Secretariat, U. K. Atomic Energy Authority, Harwell, England

THE CALDER HALL reactors, and those that will be employed in the nuclear power stations which are now under construction in the United Kingdom, operate at relatively low temperatures. The reactor coolant gas from any of these systems is, in fact, at a much lower temperature than the combustion gases on conventional coal or oil-fired power stations.

Because increasing temperature leads to improvement in the efficiency of a power plant there is a great incentive to look for means of raising the operating temperatures of nuclear reactors. The most advanced reactor system which is now being developed in Britain in order to achieve this purpose is the high temperature gas-cooled (HTGC) reactor.

Compactness an Objective

The object of HTGC reactor studies is to develop a reactor which might be suitable for either power station or propulsion applications. The outlet temperature of the gas circulating through the reactor core would be sufficiently high, not only to serve the most modern steam generating equipment but also high enough to operate an efficient gas turbine power plant. This temperature is much higher than can be obtained in any reactor based on water or organic liquid cooling. A second objective of investigations is to make a reactor which is very compact by comparison with the gas-cooled power reactors being built at present.

An HTGC reactor could not use natural uranium fuel. Highly enriched uranium-235 would be used in the first instance, and this would be mixed with thorium, so that as the reactor operated, the fissionable isotope uranium-233 would be generated to replace the uranium-235 as the latter was consumed. A combination of uranium-233 fuel with thorium as the fertile material can form the basis for a thermal-breeder reactor; that is to say, a reactor, operating with thermal neutrons, in which sufficient fissionable material is generated from neutrons absorbed in thorium to compensate completely for the loss of the fissionable material burned. In the case of plutonium with uranium as fertile material, this is possible only in a fast reactor.

Alternative Moderators

As it is envisaged at present, the HTGC reactor would be of the thermal variety and graphite or beryllia (beryllium oxide) are being considered as alternative moderating materials. Both of these materials are highly refractory and are appropriate substances for use at high temperatures. Because of the high temperatures, the uranium-235 and thorium must also be used in a refractory form.

It is proposed that the uranium and thorium should not be separated from the moderator in a lattice arrangement, as is the case in the Calder reactors, but that they should be dispersed in the graphite or beryllia. As a consequence the heat energy from the fission process would be released uniformly throughout the volume of the reactor core instead of being concentrated in a relatively small volume of fuel which is the case in existing gas-cooled reactors.

Two Advantages

Two advantages result from this procedure; in the first place it makes it possible to remove a much larger amount of heat from a given volume of reactor core and, secondly, there is every reason to believe that radiation damage would be much smaller in the dispersed material than in the metal fuel rods of present-day reactors. The dispersion of fissionable and fertile material in the moderator thus should make it possible to design very compact reactors capable of supporting a high degree of "burn-up" of the fissionable material.

One of the problems which has to be resolved in designing a high temperature gas-cooled reactor is that of preventing excessive contamination of the coolant by fission products escaping from the fuel elements. The problem is aggravated in the HTGC system because of the very high temperatures which would exist inside the fuel elements.

Metal sheaths might be used,

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though the high surface temperatures, up to or even exceeding 1000 C., would preclude the use of all but a very small number of metals. In some applications stainless steel might be employed, but this would result in a rather serious loss of neutrons, due to absorption in the steel and, as a consequence, the breeding ratio and the useful life of the fuel elements would be reduced. To overcome this difficulty a fuel element sheath made of graphite, in a relatively impermeable form, is being actively investigated. If such graphite is used, it may be possible to allow a small bleed of the coolant gas to pass through the inside of the fuel element sheath to flush out the accumulating fission products. The highly active bleed flow would be passed through a fission product trapping system before being passed back into the main coolant stream. If this principle could be applied successfully it would be possible, therefore, to transfer fission products continuously from the core of the reactor into an external container.

The high surface temperatures of the HTGC fuel elements, particularly if graphite fuel sheaths are employed, may lead to a restriction in the choice of coolant gas. Two gases which appear to be most suitable for use with graphite-sheathed fuel elements are helium and nitrogen. In either case a high degree of purity, particularly freedom from oxygen, carbon dioxide or water vapor, will have to be maintained to prevent excessive corrosion of the very hot graphite surfaces. The choice of coolant gas would be less restricted if stainless steel sheaths were used or if the moderator were beryllia instead of graphite. Carbon dioxide or air might then be used as a coolant gas.

Credit Where Credit Is Due

In the article on Ultra-Pure water for nuclear plants in the August issue of ATOMICS, on page 43, the author explained that the flushing of the resins into separate tanks was an innovation developed especially for this system, (the Dual-Cycle System) shown in Fig. 6. This statement is quite correct. However, our caption under Fig. 6 read as follows: "Flow diagram of externally regenerated mixed-bed ion exchange unit designed by Graver Water Conditioning Co."

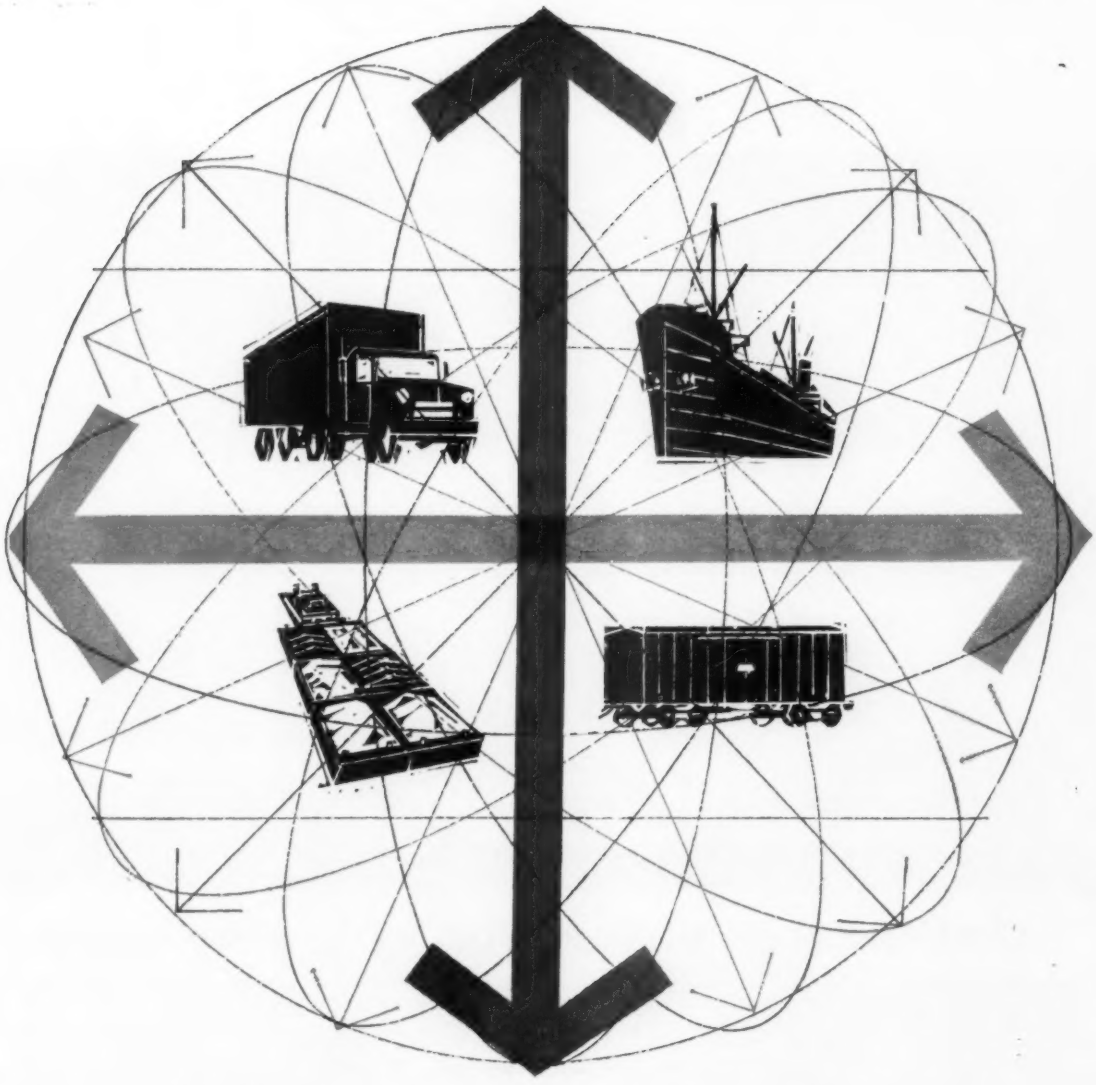
Both of these statements are true. However, H. W. Frazer of Infilco, Inc., writes to us as follows: "Both statements are true but, anyone reading the article would be led to believe that the 'innovation developed especially for this system' was developed by Graver Water Conditioning Co. All the published facts we can find indicate that the pilot studies reported in March and the full scale plant designed and built for General Electric Co and Commonwealth Edison Co by INFILCO and now installed at Dresden Station give the true story of the development of the innovation. . . . We do commend Mr. Homer on his fine article but we feel the import of these statements does warrant our bringing it to your attention." With this letter, Mr. Frazer sent us a copy of the technical paper "High Flow Rate Demineralization of Condensate for Boiling Water Reactors" by A. B. Sisson of Commonwealth Edison Co, R. C. Reid of General Electric Co, and H. W. Frazer of INFILCO Inc., which verifies his claim.

We regret the implication which, of course, was purely inadvertent, and hope that this explanation establishes the facts to the satisfaction of everyone concerned.

New Nuclear Literature

ONE of the most informative publications concerning the state of physical research in the United States that has come to our attention is the report of the recent "*Hearings before the Subcommittee on Research and Development of the Joint Committee on Atomic Energy*," of the 85th Congress of the United States. These hearings were held during the second session of Congress from February 3 to 14, 1958, and involved the physical research program as it relates to the field of atomic energy. People not familiar with the reports of special congressional committees may be inclined to assume that such reports constitute rather dry reading, yet, nothing could be further from the truth. While this particular report relates to the field of atomic energy, a field which is inherently of great interest, this report is not an exception. Many of the recent reports in other fields which have come to our attention are equally informative. This report on the physical research programs contains the detailed testimony of perhaps as brilliant and important a group of scientists as could possibly be assembled anywhere. It contains not only their oral discussion before the Committee but also their detailed prepared and documented statements, complete with diagrams, charts, and supporting data of unusual scientific interest. Of great interest, for example, is the astonishing amount of valuable information on research in the controlled thermonuclear field. Of the 785 pages included in this report, probably from one fourth to a half are devoted to thermonuclear research. Detailed descriptions are given of the work at Princeton, at Los Alamos and other of the AEC laboratories. Aside from the fact that the report does contain this wealth of information, it is reassuring to know something of the detail with which our congressional committees investigate these national problems. The report is issued by the United States Government Printing Office, Washington, D. C. * * * Another Government report of interest to everyone concerned with the development of nuclear energy is the *Twenty-fourth Semiannual Report of the Atomic Energy Commission*, issued in July. This is the last semiannual report to be issued while the Commission was under the Chairmanship of Lewis Strauss, whose term expired June 30. Aside from its customary interest because of its discussion of the many activities of the AEC, this one also contains a great amount of information concerning the AEC's work in the field of controlled thermonuclear research, indeed, the entire second part, some 55 pages, is devoted to that subject. Copies of the Report can be obtained from the Atomic Energy Commission, Washinton 25, D. C. * * * The *Fourth Annual Report of the United Kingdom Atomic Energy Authority*, just received from England, does not compare in size with the 24th Semiannual Report described above but it is nevertheless of equal interest since it describes what Great Britain is doing in the field of nuclear energy, and this is considerable. In the British report, also, considerable attention is given the subject of thermonuclear research. The work with ZETA is summarized and further work with this equipment is outlined. Work on controlled thermonuclear reactions is also being done at the Atomic Weapons Research Establishment, where effort has been largely concentrated on the particular problem of achieving high temperature in the gas. Electrical discharges are used to produce cylindrical shock compression which heats the gas to very high temperatures. The electrical circuits have been designed so as to achieve high rates of discharge current and values exceeding a million million amperes per sec are measured. The British report comprises 68 pages and is available from Her Majesty's Stationery Office in London at a price of 4s. 6d net ($1.26 U. S.).

ATOMICS



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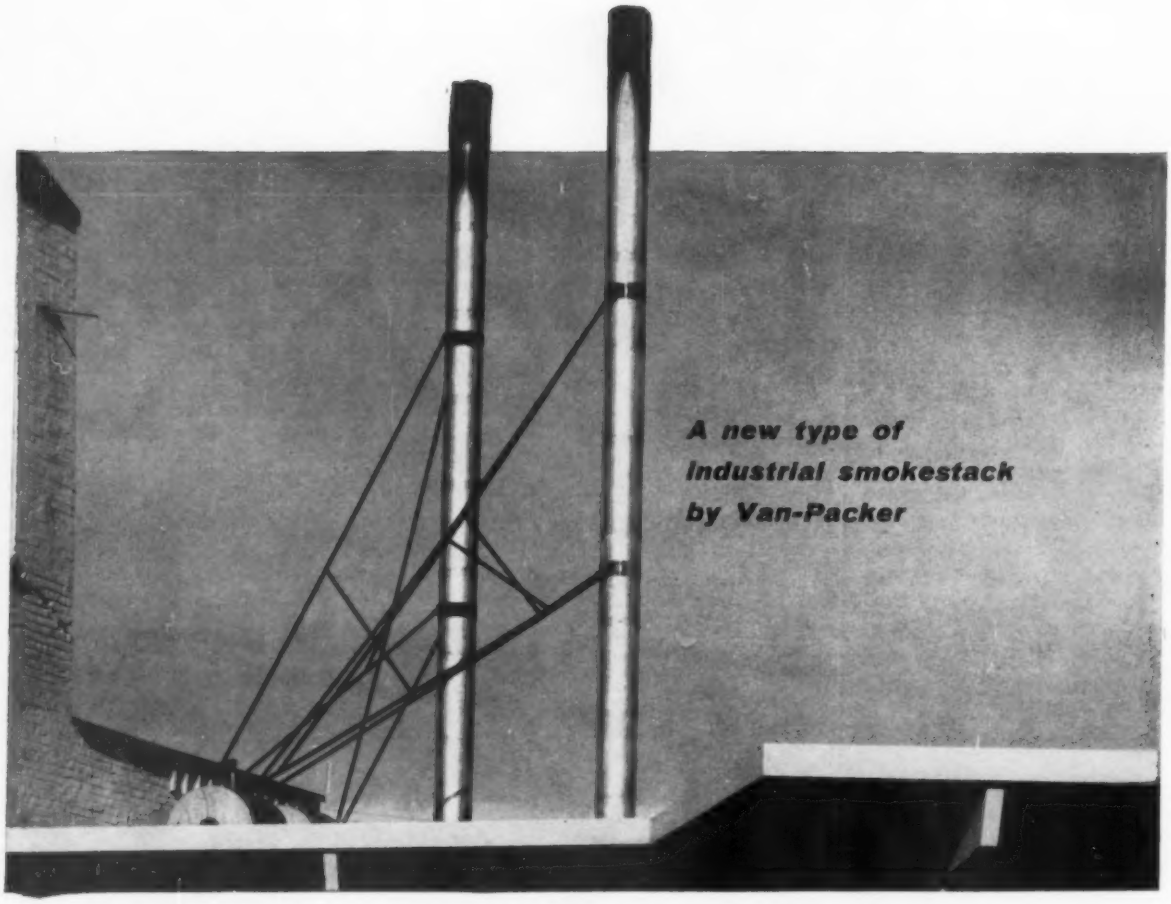

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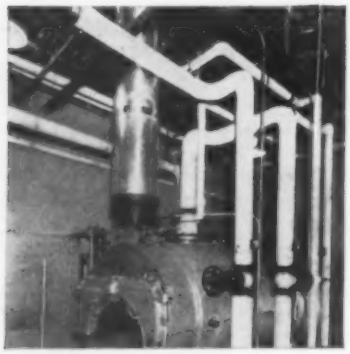

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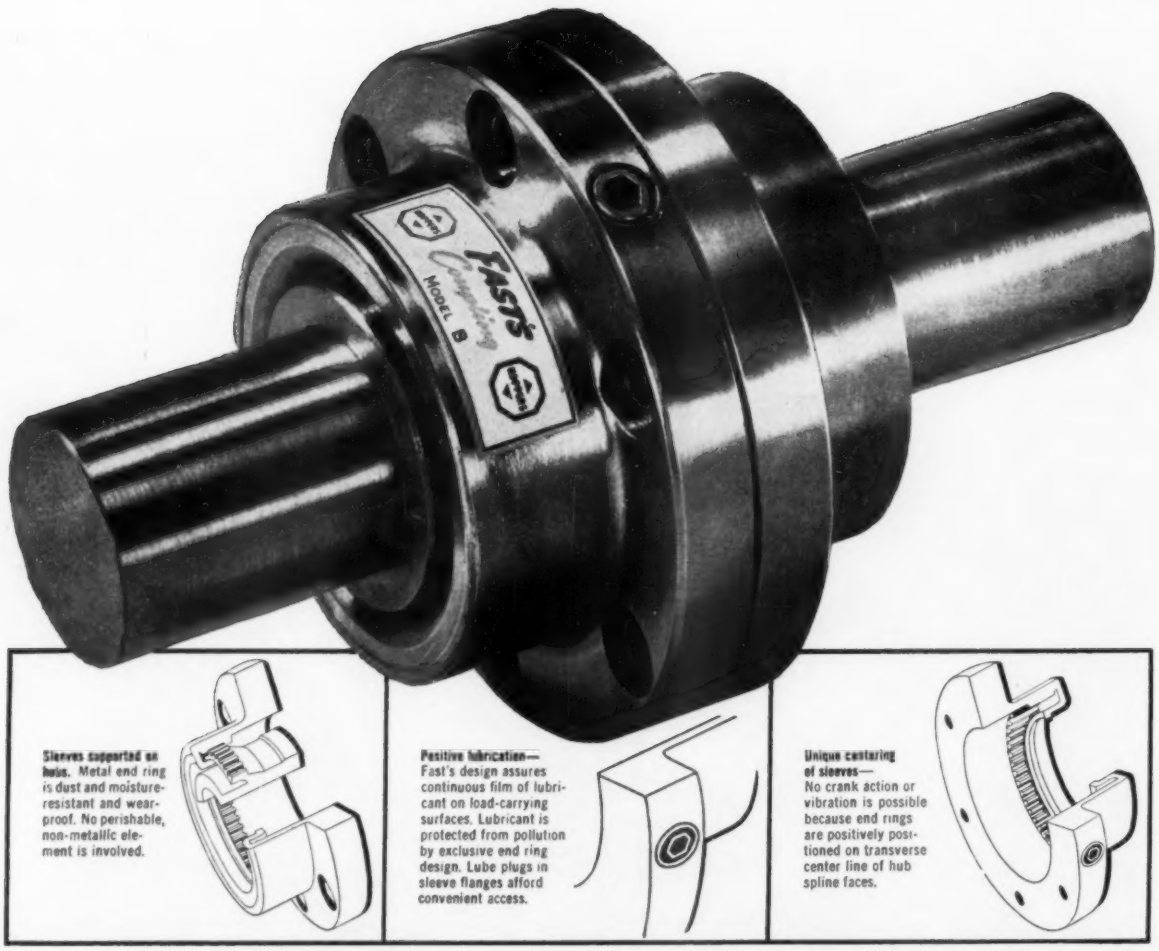
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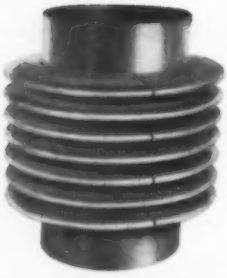
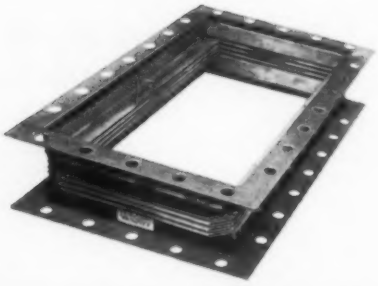
Solar  builds 

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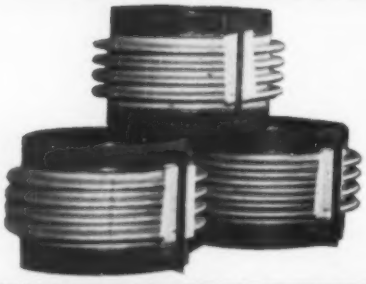
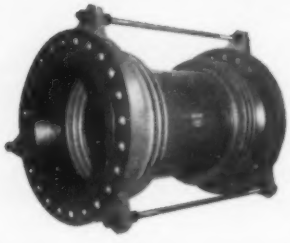
array of  industrial

expansion joints 

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TRACERS

Power Engineering's Monthly Probe of Power Facts

New family of thermoelectric materials capable of direct conversion of heat into electric power has been announced by Westinghouse scientists. The materials are inexpensive ceramics, and Westinghouse reports them to be the first solid-state thermo-electric substances to operate with "promising efficiencies" at the elevated temperatures (2000 to 3000 F) required for power generation.

How much can you save through planned incremental loading for a power system? For an average non-metropolitan system with 1000 mw of installed capacity, annual saving from the transmission loss component alone is estimated at around $50,000, while annual saving from the fuel component would perhaps be three to four times greater. See S. W. Anderson's article, page 72 of this issue, for an analysis of planned incremental loading, including cost factors.

Electric heating for homes in the Chicago area gets a boost from a new low rate now being offered by Commonwealth Edison. For residential customers, the rate fixes a charge of 1¾ cents per kwh for all electricity used over 500 kwh a month. This is about 30 per cent below the present minimum average residential rate of 2½ cents.

Turbine blade failure in the turbine generator of the Experimental Boiling Water Reactor at Argonne National Laboratory has been traced to a notch in the blade root. Blade and its shroud became detached from the rotor. One of the fixtures used to hold the blading during machining had been incorrectly adjusted, causing a notch in the root fillet, which became a point of stress concentration. Corrosion apparently did not play a part in the failure.

Waste treatment and water conservation often present a two-headed problem for industry. When both are successfully dealt with in one system which also improves heat transfer and corrosion control in cooling systems — that's news. It's what the Atlantic Refining Co has done in its chemical-flocculation waste-treatment plant in Philadelphia. Merman and Roth give the details in their article in this issue, page 80.

Stainless steel tubes — all 9234 of them — have been used by Monongahela Power Co to retube a complete main steam condenser at Rivesville Station in West Virginia. Said to be the first time a complete condenser has been so outfitted, stainless steel was chosen for its corrosion-resistance, its estimated life expectancy of 30 years.

Insidious nature of the materials used in nuclear plants is well demonstrated by an accident that occurred on June 13, in the Y-12 Plant at Oak Ridge, when an employe inadvertently drained a highly enriched uranium solution into a 55-gal drum. The ensuing radiation hospitalized eight men working in the area but fortunately none received fatal doses of radioactivity. The report of this accident on page 54 of ATOMICS, this issue, serves to emphasize the need for safety provisions in nuclear power plants far beyond those deemed adequate in conventional plants. These safety aspects of nuclear plants are discussed in another article in ATOMICS, page 50.

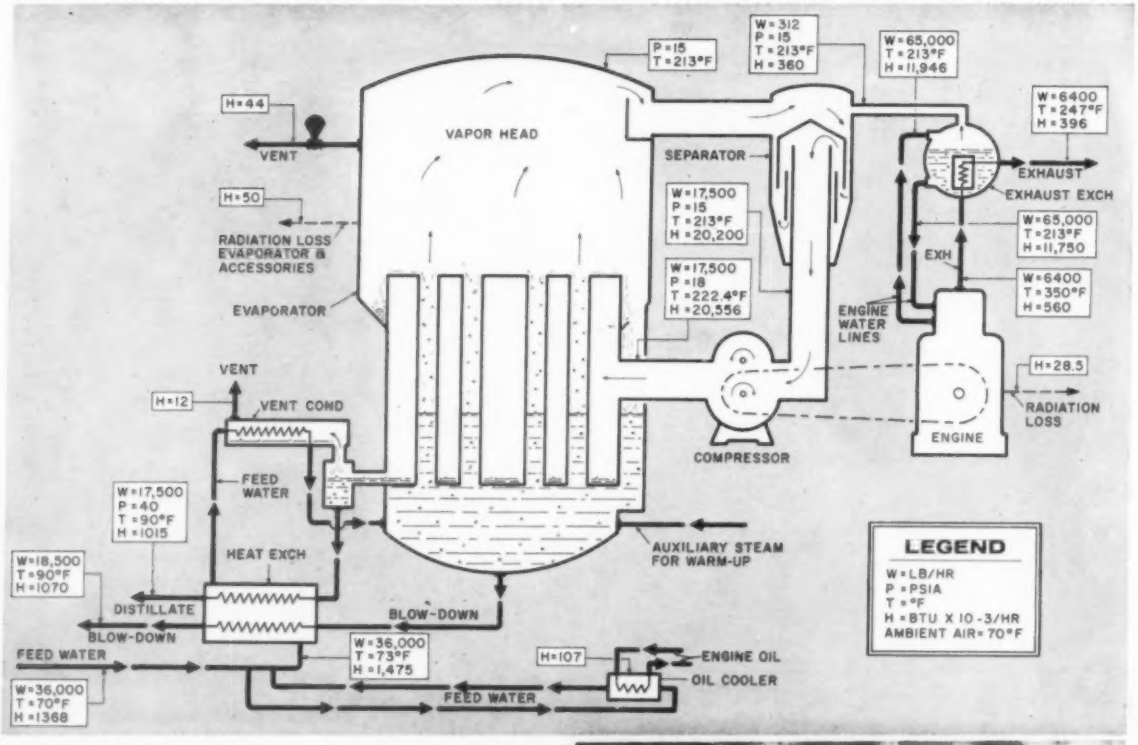


Fig. 1. Schematic diagram of basic items in one of four vapor-compression units. Also shown is theoretical heat-balance of complete cycle. Note heat recovery from every source

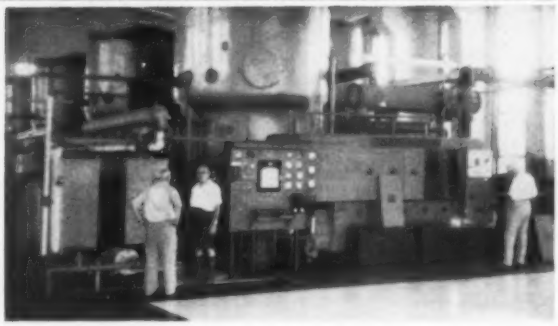


Fig. 2. Photo shows interior of distillation plant. Large shells are evaporators; diesel engine and control panel in foreground. Note exhaust gas line heat-exchanger in upper right

Power Facilities at U. S. Air Force Base on Island of Bermuda

By R. F. McCAW
Managing Editor, POWER ENGINEERING

BERMUDA is one island that has no natural ground water — and no fuel. All potable water is collected from rainfall, or is distilled from sea water. Collection of rain water is a relatively simple matter. However, if additional water is required, the sea-water distillation process is quite complicated, and presents many problems. This is the story of how one Base does it.

One of the strategic Air Force bases operated by the United States is Kindley A.F.B. — on the island of Bermuda. This spot is some 800 miles off the seacoast of the U. S., and directly east of Charleston, S. C.

Most Americans know Bermuda as a beautiful vacation spot. However, from a military standpoint, Bermuda is a most important stepping-stone — in the Atlantic, on the routes to Southern Europe and Africa.

Behind the scenes, a military airport is a composite of many factors. First, its business is that of supporting, maintaining and refueling of aircraft. This alone, is a gigantic business. It involves airstrips, landing facilities, hangars, maintenance shops, fuels-handling, cargo facilities, traffic control — and all other aspects of a commercial or military airport. Many mechanical and electrical facilities are included in this category.

To staff such an establishment requires a lot of manpower — and most of these men are in the technical category. Modern military aircraft are very complicated pieces of equipment, requiring specialists of all types to properly service and maintain them. And, to back up these specialists, there are many more who supply the non-technical support of the base.

Kindley A.F. Base is typical of many U. S. military airports, insofar as *operations* are concerned. But,

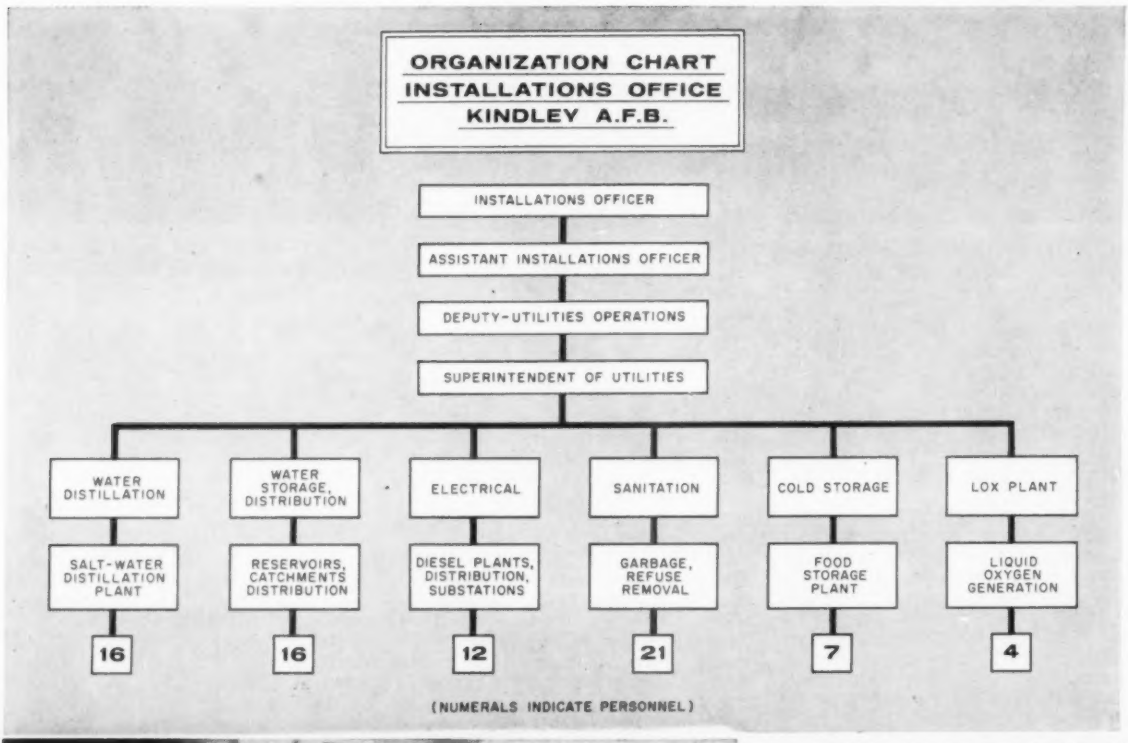


Fig. 3. Chart showing organization of Installations Office at Kindley A.F. Base. Figures show departmental personnel

Fig. 4. Part of utilities staff at Base, taken after meeting with POWER ENGINEERING's R. H. Morris and R. F. McCaw

Supporting its crews in the air, with necessary services, is a big job for the Air Force. No small part of this support are the power facilities. Vital utility at Bermuda is its water supply. Rain and sea water are the sources; here's how they use this water most economically

there is one major difference which sets it apart from most of the others: — it is on a tiny island, in the ocean, without any natural resources to support it. No fuel — no water — no food — no service shops — no supply stores; — none of the many services enjoyed by the average airport in the continental United States.

The military establishment at Kindley comprises some 4500 personnel; this is equivalent to the average U. S. city — and requires the same utilities. These people — men and their families — must be supplied with water, electricity, sewage, cold storage, street lighting, fire protection, garbage disposal, storm sewers, streets, police protection, and all the various services required by any other community of similar size.

Why, then, is this story unusual; what sets Kindley apart from any other similar military community? And what makes its power facilities more unique than thousands of other such installations in the U. S.? The answer is simple: — no natural resources. Water is precious on Bermuda!

How is life supported in this island paradise? First, concerning water: There is no groundwater of any consequence, so each family is completely dependent upon *rainfall*. And how is this collected? This phase of the "Bermuda story" is a complete narrative in itself, because it is so basically simple — and yet so vitally important.

Rainfall Collection

All of the roofs — on residences and commercial buildings — are practically identical; they are pitched roofs, with an integral gutter which directs all rainfall to the roof leaders — or "downspouts". These pipes run to a reservoir, which is usually under the building. Then, the water is lifted back into the building by a pump —

Fig. 5. Typical catchment area, being inspected by Kurtz, Kendall and McCaw

either manually or electrically-operated. These roofs are generally of masonry construction, and are kept painted at all times.

A lime solution — or white-wash — is used for this purpose. Its white color gives excellent reflectance to sun glare, and the lime acts as a mild sterilizing agent.

There is no purified water distribution system; each household, or business, gathers its own water. In normal seasons, this practice is quite satisfactory for homes and businesses. However, it is far from adequate for a U. S. military establishment. Americans, generally, use more water, per capita, than any other nationality. This fact, plus the normal water requirements of an Air Force base, create a very major problem to the military personnel on the island.

Two types of rainfall collection are used on Bermuda; every roof is utilized as a catch-basin, and this is supplemented by man-made catchment areas — on hillsides. These catchments are quite simple. A strategic hillside is cleaned of all vegetation and soil (which is very shallow); then the area is sealed — by Gunite process — with concrete; next it is white-washed, and the area is complete. Around the bottom, top and sides of the area, a retaining wall is built; this directs the water to a sump, at the lowest point in the area. Then the water flows by gravity, or is pumped to a reservoir in the vicinity. From here the water enters a piped system which leads to the point of consumption. Figure 5 is a typical catchment area, being inspected by Kurtz, Kendall and McCaw.

Every two years, it is necessary to apply a cement-wash to the catchment areas, to seal the cracks which have developed.

So far, so good! But what do you do when you require twice as much water as can be collected (economically) from rainfall? Two solutions to this problem: 1. Ship the water in, from another country, by tanker or barge; and, 2. make pure water from sea water. Naturally, rain water is free for the taking — provided there is enough of it; however, producing the water by distillation, or bringing it in by tanker, are quite expensive methods.

The providing of water, from rainfall, is a very simple process; just collect it by gravity, and pump it into the distribution system. But the matter of economics comes into play, in the balancing of rain-water versus distilled water. The Air Force utilities people are a very conscientious, cost-minded group of people. They know, at first hand, that any method of distilling sea water is expensive; therefore, they "play by ear" — in the maximum utilization of rain-water, and the minimum use of distilled water.

Distillation Economics

As we have mentioned in previous articles in POWER ENGINEERING, the distillation of sea-water is expensive. An article entitled Fresh Water From Salt — Three Ways (December, 1957), gave some typical costs of distillation. These costs were the best possible, gained under ideal conditions; however, many factors influence any such cost analysis. Fuel cost, labor rates, maintenance expense, type of system, and load-factor — all come into the formula.

At Kindley A.F. Base, an average cost of distilled water, pumped into the water distribution system is about $3.48 per thousand gallons. This may sound ridiculous to the operator of a conventional U. S. municipal water system, who produces water at an average cost of 15 to 20 cents per 1000 gallons. However, to one experienced in sea-water distillation, Kindley's cost is about normal.

The cost mentioned is an average — based on the erratic operating schedule, which is prescribed by Mother Nature; that is, every drop of rain is used first, then the balance of the required water is distilled from sea-water. Every experienced operator knows that his best efficiency comes with a 100 per cent load-factor — if that is practicable. However, when an *optimum* crew of operators is required — day in and day out, regardless of output — costs can vary all over the scale.

Maintenance of Equipment

As can be noted from the Organization Chart, in Fig. 3, the Distillation Plant at Kindley employs a minimum number of personnel. Also, this staff handles operations and maintenance. Most power engineers think of maintenance as the routine checking and lubrication of their equipment. This is only part of the story in a water distillation plant, however. The nature of the cycle in sea-water distillation is such that the evaporators must be shut down for cleaning approximately every 15 days. (This is true of vapor-compression stills, which is the type installed at Kindley.)

A schematic diagram of the distillation equipment is shown in Fig. 1. It should be noted that every possible source of heat is utilized in the cycle. This includes the exhaust heat from the diesels which drive the compressors. Heat-exchangers are utilized in every instance where Btu's can be salvaged. While this all contributes

Fig. 6. One of four Read-Standard steam compressors in distillation units

to the efficiency of the heat balance, each heat-exchanger does present a major maintenance problem. Salt water is extremely corrosive; and, for some strange reason, the ocean surrounding Bermuda seems to be more so than at other coastal areas.

Manufacturers who produce salt water distillation equipment select product materials based on all available research data. Then, when the equipment is placed in service, new operating data are obtained. The users confer with the manufacturers, so that all operating experience will contribute research information for future designs. The distillation equipment at Kindley A.F. Base consists of the following basic items, all coordinated under a principal contract to Cleaver-Brooks Co, of Milwaukee: —

4 — Fairbanks-Morse Diesel Engines, driving:
4 — Read-Standard Compressors
4 — Cleaver-Brooks Evaporators
2 — Cleaver-Brooks Warm-Up Boilers

(Total rated capacity of the plant is 200,000 gpd.)

Method of Operation

As can be seen from the schematic diagram in Fig. 1, sea-water is preheated, sent to evaporators, heated, distilled, and sent into the water distribution system. Distillation is effected in the evaporators, which derive their heat from vapor-compression compressors — driven by diesel engines. This cycle is basically simple; it is continuous, and requires little maintenance — *until the evaporators need cleaning.* Then the headaches start! As mentioned, these vapor-compression stills must be shut down and cleaned about every 15 days. This shut-down involves many maintenance jobs. Just the clean-out of the deposited salt is a project in itself. And the diesels must have their share of attention, also.

Salt is condensed into brine, in evaporators, and pumped back to the sea. However, much salt is precipitated in the evaporators — as scale — and must be removed during shut-down. This is done by circulating muriatic acid through the evaporator cycle, flushing all piping and equipment, and restoring the equipment to operating condition.

At Kindley, there are 4 distillation

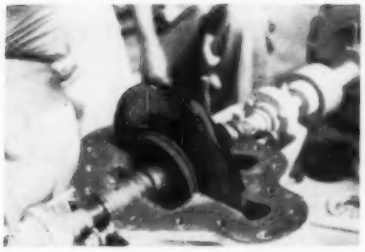


Fig. 7. Impeller of salt-water pump, badly corroded in less than seven months

units, each capable of producing 50,000 gal of water daily. Cleaning of these units requires about 2800 lb of acid, every 15-day cycle. Acid cost, delivered at the base, is about 15 cents per lb. Current tests of other chemicals might lead to a substitute material which would cut cleaning costs drastically. (Acid, in liquid form, must be shipped to the base in carboys; the cost of shipping and handling of these carboys is quite expensive.)

Fuel oil — for electric generation, heating and water distillation is sent to Kindley by tankers — from a shipping point in the U. S., or in the near East. This oil, at the moment, costs about 10 cents per gal; this varies according to market price, and length of haul. The oil is unloaded at dockside, and pumped to storage tanks. Conventional fuel-oil handling equipment is used — from tanks to diesel engines.

Effects of Corrosion

In addition to the cleaning of the evaporators, the diesels require routine maintenance, as well. This includes inspection and maintenance, plus the cleaning of filters, exhaust gas heat-exchangers, etc. Also, circulating pumps, valves, strainers, motors, and other salt-water equipment require a lot of maintenance. Some metal pump impellers, designed for salt-water use, seem to corrode to the point of inoperability — in a very short time. Figure 7 shows a pump which had been in service less than seven months. This is indicative of the corrosion being fought constantly at Kindley.

Careful records are kept of all vital statistics at Kindley; such unusual things as amount of rainfall — at each catchment area. (A rain on Bermuda might deliver one or two inches on one part of the island, and absolutely none at another location.) These statistics are carefully maintained — and plotted on graphs, for daily use in predicting the next week's operations. Several times in past years, it has been necessary to import water from the United States. Now, however, water is so carefully managed that surplus rain water is stored in a barge, and used during the next period of shortage.

Two separate water distribution systems are utilized, to effect maximum utilization of salt water. One system handles all potable water, while the other distributes salt water to fire hydrants, toilets and urinals.

Distillate from the plant is mixed with rain water, thus bringing the pH up to a satisfactory level. Once, during a drought, it was necessary to use practically all distilled water. This dropped the pH so low that numerous corrosion problems were experienced.

The condition was relieved, temporarily, by mixing a small percentage of sea water with the distillate.

A team of corrosion experts visited Kindley early in 1956, to make a complete study of the problems in the distillation plant. These experts, together with the staff of the Installations Engineer, made an analysis of each individual case of excess corrosion.

As a result of this conference, several remedial measures were taken to substitute new materials for some of those used in the original designs. This did help, of course; however, the battle of corrosion continues to be a constant problem.

Who Provides the Utilities?

As in any American municipality, or big industry, there must be a utilities organization which supplies all of the needed services. The Air Force has such an organization, at each of its Bases, known as the Installations Engineer's Office, which is directed by military personnel. The organization chart of Kindley A.F. Base is shown in Fig. 3. The director of this group is known as the Installations Engineer; he is the counterpart of a City Manager, a Chief Engineer, a Director of Utilities, — or any one of many "public officials" who supply the services for health, protection and comfort of a community.

Under the Installations Engineer is a well-qualified assistant; these men are generally engineers — with many years of experience. At Kindley, Lt. Col. Leonard Reppert — and his assistant, Capt. McMichael — do a most commendable job of keeping the wheels rolling.

Since military personnel are rotated from one location to another, it is necessary to have a permanent civilian engineer to head up the utility operations. Kindley is fortunate in having Edwin H. Kendall as Chief of Utilities, supported by an extremely capable staff of supervisors, consisting of Messrs. Coons (Superintendent), Black (Electrical), Benicke (Distillation), Donahue (Sanitation), DeConto (Cold Storage), VanBuskirk (Liquid Oxygen Plant), and May (Water Distribution).

These men have the responsibility of providing day-by-day utility services to the base, plus planning for expansion — and fighting the problems of corrosion from salt water. And — they take all this in stride! There's no "corner store", where supplies can be bought on a moment's notice. Nor is there a major electrical service shop, or mechanical repair shop, to handle all of the many problems which arise each day. Just the routine requirement of furnishing 1.0 million kwh of electricity, and 5.7 million gal of water monthly, is no mean task. Yet it's done, month after month. Fig. 4 shows the power engineering group; officially, the Installations Engineer's staff. (Photo was made immediately after Editorial Director Dick Morris, and Managing Editor Bob McCaw had made talks to the group.)

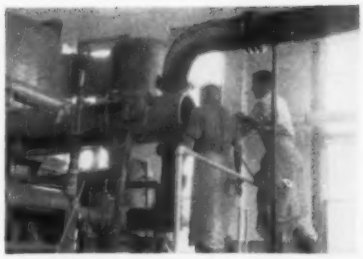


Fig. 8. Operators cleaning the heat-exchanger on diesel engine exhaust line

In comparison with typical power installations in the U. S., the facilities at Kindley A.F. Base are being operated and maintained very efficiently, at minimum cost, and under conditions so severe that very few mainland installations can be considered as comparable yardsticks.

Experts Manage All Utilities

The men at Kindley, who operate and maintain the power facilities, are a dedicated group; most of them have been there for years; and all are experts in their fields. This base is operated by MATS (Military Air Transport Service); this Command of the Air Force has its headquarters at Scott A.F. Base, Scott Field, Illinois. At the present time, Col. Robert Greigg heads up the Engineering Divn, assisted by Lt. Col. Jos. Aebischer. Mr. A. Lawrie Kurtz is the staff expert on water problems for MATS, and was the capable host of POWER ENGINEERING editors on the trip to Kindley A.F. Base.

In Washington, at top level for the Air Force, Major General A. M. Minton is responsible for all facilities of the Air Force — world wide. Col. James Carney, under Major General Minton, carries direct responsibility for all utilities operations. (Col. Carney was stationed on Bermuda for some time, and was responsible for many of the present operating economies now in force.)

As power engineers, editors familiar with the field, and *taxpayers*, we sincerely feel that the Air Force personnel are doing an outstanding job — in their remote bases, where it's a case of "doing the best you can, with what you have at hand".

(*Editor's Note:* — Subsequent articles will tell the story of electric generation at Kindley; also the total utilities problems at Lajes Field — in the Azores. THE END

Planned Incremental Loading Gives

Author describes various methods of loading generators and transmission lines, point out the cost factors involved in figuring economic operation, gives the *why* and *how* for planned incremental loading under various load conditions, with appropriate examples

By S. W. ANDERSON*

MOST PRESENT-DAY power systems contain two or more power generating stations with numerous generating units. Many systems have interconnections with neighboring utilities. Some of these interconnections float, some carry power one or both ways, while some carry vars only.

Many systems have purchase agreements with neighboring companies. These purchase agreements may cover emergency power only, dump power, or normal power. Some systems have power or vars flowing by displacement through parallel neighboring systems. Many systems carry power or vars through their own system for neighboring systems.

Typically, system loads vary up and down in a more or less regular pattern through each day, week and year. Only at time of system peak are most of the generating units fully loaded. Interconnections have loading patterns that frequently follow the normal load variations. However, more frequently, they have their own particular loading pattern.

Usually, each generating unit differs from every other unit in the system as to efficiency, size, and characteristics. Some plants are located at load centers, while others are located in places remote from load centers feeding power over long transmission lines with their accompanying transmission losses. Frequently two or more load centers, with one or more plants each, exist on a system and are tied together with a more or less adequate transmission system.

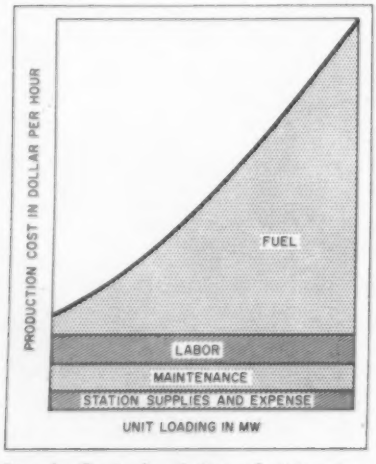


Fig. 1. Typical relative electric production costs per unit *vs* mw loading

Fuel costs may vary considerably from area to area. Transmission capacities of existing lines are sometimes low. As a result, there is for each particular system load, between the maximum and minimum periods, one particular way to allocate this load to the various generating units and interconnections in order to gain the lowest system operating cost.

Cost Elements

It is desirable and profitable to know for any particular system load exactly what proportion of that load to carry on each generating unit and interconnection, so that the total cost of operation will be at a minimum.

Let us first consider a simple system where two generating units are located in a single plant and where there are no interconnections with neighboring utilities. Such a system may represent a municipality surrounded by power systems but not connected to them, or it may be a small system in a geographically-isolated location.

The four major production cost classifications for each unit of that plant are fuel, labor, maintenance, and station supplies and expense.

Assume for the moment that the system load is such that each unit is operating at half load. If the loading on one unit is increased or decreased, only the fuel costs change to any significant extent. The labor force remains unchanged whether the unit is operating only partly loaded or fully loaded, and thus, the labor costs remain constant.

Maintenance and station supplies and expense will vary somewhat with changing loads. However, these variations are not always uniform, and will remain relatively small in their effect upon the over-all production costs. They appear to follow no known mathematical laws, and any attempt to assign a mathematical equation ot them approaches a pure guess. The variation, compared with that of fuel, is small.

If load is shifted from one unit to the other, the fuel cost of the one will increase and the other decrease, and in general, at different rates. All other costs remain essentially constant. Thus, in single plant systems, the fuel cost is the important variable, as is shown in Fig. 1.

Assume now that another particular system has two generating plants, each with two different generating units, connected by a single major transmission line. As before, if load is shifted from one unit to the other unit, of, say, Plant A, the fuel cost of one unit will increase, while that of the other will decrease by a somewhat different amount. The total cost of production of Plant A, and as a result, of the system, will change somewhat, and this change will be almost entirely due to the change in the amount of fuel consumed.

However, if load is shifted from a unit in Plant A to a unit in Plant B, there will be an additional reason for change in system operating costs. The transmission losses will change either up or down, depending upon the load flow over the transmission line. Consequently, more power must be generated in one of the plants with a consequent increase in system operating costs to supply a particular load than if it were supplied by the other plant.

In addition, because of change in load distribution, this change in transmission losses may be different at one time of year than at another. Thus, there is a second variable cost to consider in systems containing two plants.

If more than two plants exist on the system, or if the two plants are connected by an extensive transmission system, the cost variables remain the same as for the two plant system. The complexity of determining them, however, increases greatly.

If power is purchased through interconnections, still another variable is introduced by the cost of purchased power. However, this variable is similar in many respects to variable fuel costs, and can be treated as such if the neighboring utility is considered to be an equivalent plant.

If power or vars flow through a neighboring system, the complexity of the problem is again increased, because the transmission equivalent of the neighboring system must be determined.

Mechanics of Economic Loading

Theory behind economic loading is highly mathematical. However, its application is very practical. Basically, it can be said that if, for some particular load, the incremental fuel cost plus the incremental transmis-

* Middle West Service Co

sion losses in dollars are equal to the same dollar value for each unit on a system, the system is operating at its most economic point. If this is true for every load on a system, the system is operating most efficiently with the lowest delivered cost of power.

Incremental fuel cost may be demonstrated as follows: If the output of a turbine generator is changed a small amount, the input fuel cost changes a small amount. The ratio of the change in fuel cost to the change in power output for one unit is the incremental fuel cost. Similarly, if output of a turbine generator changes a small amount, transmission losses change a small amount. The ratio of this change in transmission loss to the change in output is the incremental transmission loss for that one unit.

An input-output curve can be set up for each unit. It shows the fuel input in dollars per hour required to produce any output in mwh per hour. It may be represented either mathematically by an equation, or graphically, as in Fig. 2. The incremental fuel cost for any power output can be determined from the input-output curves. It may be represented by a mathematical equation, or graphically, as in Fig. 3.

Transmission system line losses are the sum of the I^2R losses in the transmission lines. They are produced by current flowing through the resistance of the various lines. It is necessary to establish a relationship between the transmission losses and the power output of the generating units. This can be done by using a set of B-constants that are characteristics of the transmission system and the load distribution.

B-constants are usually determined from known system data by means of a network analyzer and a digital computer, although for a two-plant system they may be determined by manual computation. From the line-loss equation involving B-constants, the incremental transmission losses may be determined for each plant.

An equation can now be determined involving both the incremental fuel costs and the incremental transmission losses, which, when plotted, will indicate the most economic schedule for each unit. These equations, one for each unit, are called the coördination equations, and are used to determine the loading schedule of each generating unit to produce the lowest delivered cost of power.

Coördination equations have been known for some time; however, for most systems, solution of them manually is so involved as to be almost prohibitive. In recent years, digital computers have become available, which, in conjunction with network analyzers, make the solution of the above equations very practical and economically feasible for almost every system.

An alternate method is to determine a penalty factor from the incremental transmission losses and to apply it to the incremental fuel costs to form a generation schedule. This method finds application in certain slide rules and computers.

Making the Study

It is necessary to arrive at an important conclusion before making an economic loading study. That is: Should the effect of transmission losses be included?

On an average, approximately 75 per cent of any savings available from a complete incremental loading study are due to the incremental fuel cost portion of the study, whereas only about 25 per cent of the total time involved to make such a study is due to this portion. The remaining 25 per cent of the savings are due to the incremental transmission loss portion of the study, and require about 75 per cent of the total time to make the study. The question each system must answer is whether the savings involved justify inclusion of the effect of transmission losses in the study.

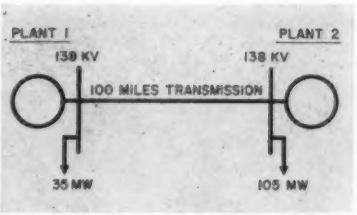


Fig. 4. Equivalent system for example. Transmission losses were considerable

It appears to be always worthwhile to make a study of the incremental fuel cost portion, regardless of the size or complexity of the system, so long as more than one unit exists on the system. The probability is it will not be worthwhile to include transmission losses for a very compact system, such as a small metropolitan area. Transmission losses obviously should not be included for a single-plant system.

If great extremes in fuel costs exist between all plants, it appears again that it may not be worthwhile to include transmission losses; however, this depends upon the present manner of loading. If one large modern plant exists on a system with one or more small older plants, and fuel cost is approximately flat over the entire system, it is probably not worthwhile to include transmission losses. There are, however, exceptions and extenuating circumstances to every case noted above, and in general, each case should be carefully examined.

Procedure to follow in making an economic loading study is, briefly, as follows:

1. Test the plants carefully at various load points to determine the input-output curves, if this has not already been done. Manufacturers' expected performance data in most cases is not adequate.
2. Set up the transmission system and system loads as required on a network analyzer to obtain data for determining the system B-constants.
3. Determine the system B-con-

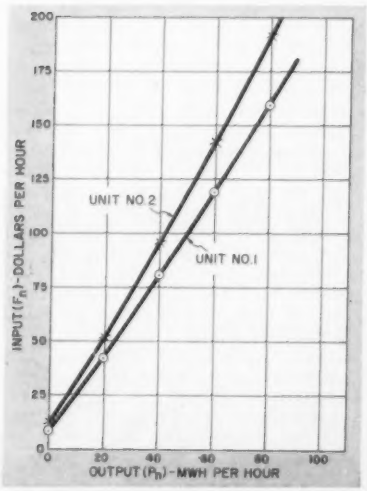


Fig. 2. Input-output curves of the two units discussed in example in article

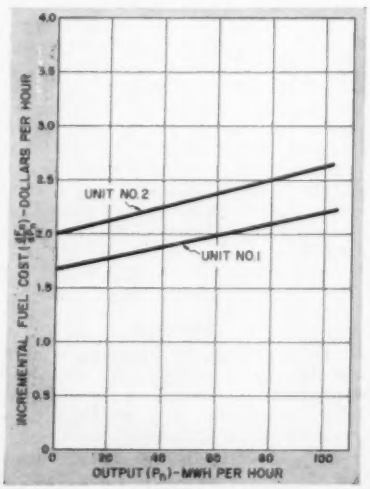


Fig. 3. Incremental fuel cost chart of the two units, basic to proper loading

stants for use in the loss equation, using, if necessary, a digital computer.

4. From the loss equation and the input-output curves, determine the coördination equations, if this method is to be used.

5. Solve the coördination equations on a digital computer, if necessary, to determine preliminary generation schedules.

6. Check the preliminary schedules on a network analyzer to find system transmission limitations that may require deviations from an ideal generator schedule.

End point of the above study is data which indicates the most economic generation schedules to be carried on each unit for any system load for a number of normal and emergency conditions.

Loading Devices

There are a number of ways the data from an economic loading study may be portrayed for utilization on a system. The data may be included in a set of loading curves that serve as generation schedules. A second possibility is to incorporate the data into a slide rule. A third possibility is to load by means of an automatic device.

Loading curves are the simplest of the three to set up. They serve directly as generation schedules, and charts are required for each normal and certain abnormal conditions. However, charts are inflexible. If fuel costs change, the charts are not adjustable and they then become, at most, only an approximation. In addition, it is frequently impractical to incorporate all abnormal conditions that may arise.

Loading slide rules provide a desirable degree of flexibility, and can be designed to include a variable fuel cost scale. A number of types of slide rules may be built, the most common being for use on systems that do not take into account transmission losses. However, separate penalty factor scales may be included to take into account transmission losses.

On simple systems, the transmission losses may be included directly in the slide rule. On more complex systems, some external device, such as curves, a separate slide rule, or some automatic device may be used to determine penalty factors for application to the loading slide rule.

There are many slide rules presently in use. The author's company has designed a number of slide rules, although each one must be designed to meet the particular cost and system load conditions of the company of which it is made.

Automatic devices of various types may also be used for economy loading. Into some raw data is introduced and data for a schedule is automatically computed. The generators are then loaded in the normal manner. There are others, however, that also automatically load the generators so that they constantly attempt to follow an economic generation schedule. This is to be compared with a set of curves or a slide rule whereby the machines are brought to the economic point of generation at, say, once each hour, with in-between points interpolated.

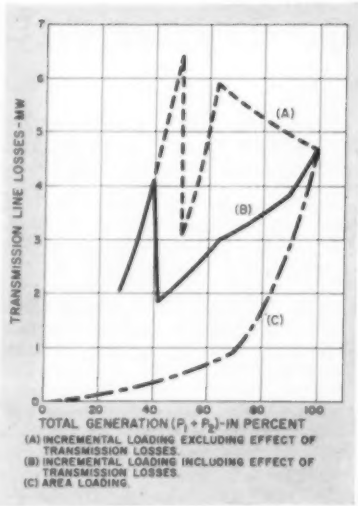


Fig. 5. Comparison of transmission losses under three methods of loading

During rapid load changes, since automatic devices do not, in general, look ahead, there is a considerable difference between actual load on the generators and the desired scheduled load. This difference may be appreciably more than that due to slide rule or curve loading. However, during slow or random changes in load, the automatic device does a somewhat better job of loading than manual methods using curves or a slide rule.

It would seem that for a very large system automatic economy loading equipment may be economically justified. However, for medium-sized or smaller system, it definitely must be determined if the difference in savings between the automatic device and a slide rule justifies the extra expense of the automatic device. It would appear that in many cases the major part of the potential savings are available from a slide rule at a much lower cost than from an automatic device. Thus, the automatic device is frequently not justified economically, though at times it may be justified for other reasons.

Savings

Savings involved vary from system to system. Usually, they are quite appreciable. According to engineering estimates, the average nonmetropolitan system with 1000 mw of installed capacity could realize annual savings from the transmission loss component alone of approximately $50,000, while annual savings from the fuel component are estimated to be perhaps three to four times greater. Very roughly, the annual savings will vary directly with the installed capacity.

In the interest of showing what savings are involved in economic loading, the following hypothetical example may be considered.

A system is made up of two separate load areas tied together by a single 138-kv transmission line that is 100 miles long. In each load area there is a single plant containing one 75-mw turbine generator with identical characteristics to the turbine generator in the other load area.

Figure 4 represents the equivalent system. Assume that the peak load of Area 1 is 35 mw and its minimum load is 10 mw. Assume that the peak load of Area 2 is 105 mw and that its minimum load is 30 mw. Assume further that the fuel cost of Area 1 is 20 cents per million Btu while that of Area 2 is 24 cents per million Btu.

Reserves are purchased from a neighboring utility from a single normally floating interconnection. Initially, a system of area loading is employed to load the two generators.

A study was made to determine what savings would be involved if incremental loading should be installed with and without taking transmission losses into account. The input-output curves of Fig. 2 were determined for the two units. The incremental fuel cost curves of Fig. 3 were not determined. The B-constants were computed to be:

$B_{11} = 0.001168$

$B_{12} = B_{21} = -0.00026$

$B_{22} = 0.00018$ (all in 1-mw units)

Generation schedules were set up and integrated over a typical load-duration curve. The following maximum annual savings over the area loading scheme were determined:

1. Incremental loading without transmission losses — $57,000.

2. Incremental loading including transmission losses — $75,000.

Above savings are the theoretical savings from following an ideal schedule. Actually, at most, perhaps 85 per cent or about $64,000 can be reached by automatic loading equipment, because it is physically impossible for most systems to closely follow some of the abrupt and rapid changes in an ideal schedule. Perhaps $60,000 in savings can be attained by means of loading with a slide rule. A somewhat lesser amount of savings would be attained by means of loading curves. As can be seen from the foregoing, however, no more than about $4,000 in annual savings in the above case can be used to justify automatic equipment.

As a matter of interest, the transmission losses for the three types of loading have been plotted in Fig. 5. They have been computed by means of the B-constants. Note that area loading has, as expected, the lowest losses; while incremental loading, without including the effect of transmission losses, has the highest transmission losses. THE END.

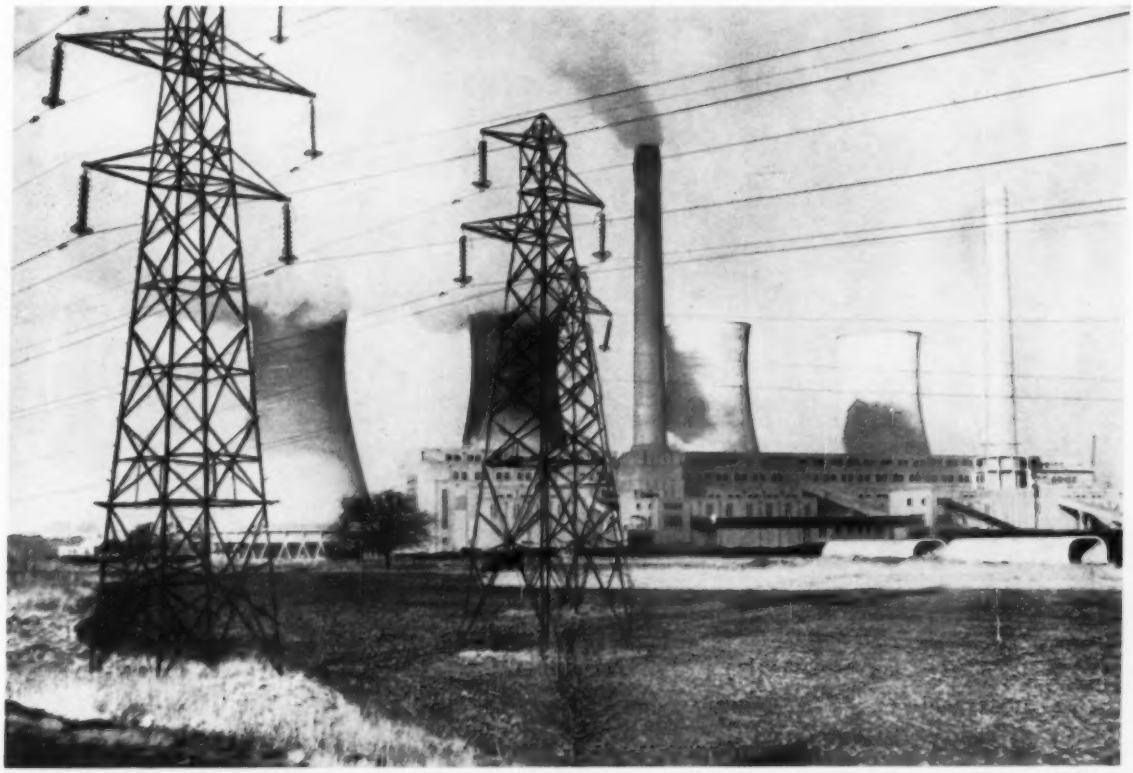


Fig. 1. Hyperbolic towers at Hams Hall Station in England. Capacity: 290,000 gpm; diameter: 220 ft; height: 310 ft

Hyperbolic Cooling Towers Invade United States Power Field

Years of successful operation, in British and European installations, influences decision to bring these cooling towers to America. Elimination of practically all maintenance — plus decreased power requirement — makes this tower interesting to American power engineers

By JAMES O. KADEL*

AFTER AN IMPRESSIVE history of service in many countries abroad, the hyperbolic natural-draft cooling tower is being introduced here by an American tower manufacturer. At the conclusion of a long period of study and observation of these radically different designs and installations, this company has determined that the hyperbolic tower has a place in our economy, and that industry would be served best by adoption of a design that has been outstandingly successful on three continents. To this end, they have secured exclusive rights to the design services of L. G. Mouchel and Partners of London, engineers who introduced the hyperbolic tower in England. They are one firm with long experience accumulated through design of more than 500 large-capacity, reinforced concrete hyperbolic cooling towers at generation stations.

Unique in design, the hyperbolic natural draft cooling tower offers to American industry a different concept for the water cooling requirement of 100 mw and larger electric power installations being planned. It offers what may be termed a permanent cooling water facility, since the first hyperbolic tower built in England is still in operation, after more than 30 years' service. The present condition indicates a much longer, but as yet unpredictable, service life. In this respect, the hyperbolic tower compares with the cooling pond, or spray pond. It has the same long life, low maintenance, no-power-demand features, but it offers many advantages not found in the exposed methods of water cooling.

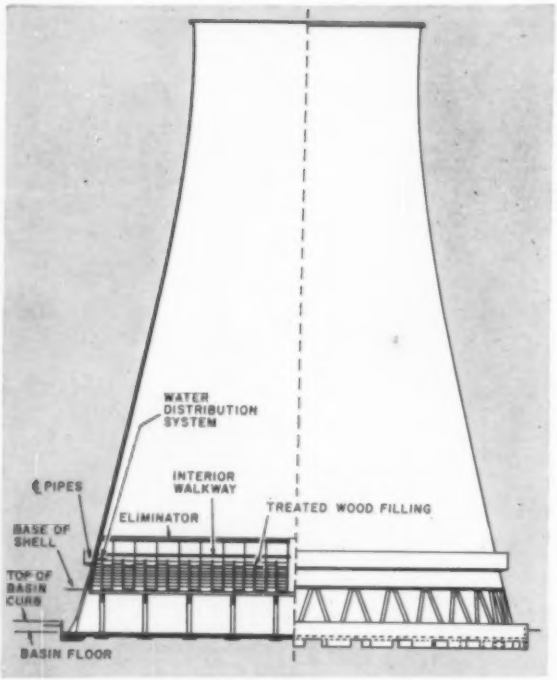
The power industry, with its requirements for large-scale water cooling, at a temperature-level in line with the capability of natural draft cooling, and an eager interest in reduced operational expenses, can best utilize this different water-cooling auxiliary.

These advantages stand out:

1. Due to its height, quite often greater than the boiler chimney, ground fogging and recirculation of warm, moist vapor do not occur. Cooling tower location nearer the condenser is now practical, with simplified and economical piping requirements. With recirculation eliminated, the plant designer may locate the cooling towers in close proximity to each other. This will allow flexibility of location within the plant, and conservative and economical pre-planning of real estate requirements with confidence. Recommended spacing between hyperbolic tower centerlines is simply 1.5 times the base diameter.

2. Atmospheric air for direct water-cooling is induced through the tower by thermal power, created by

* Senior Engineer, The Marley Co



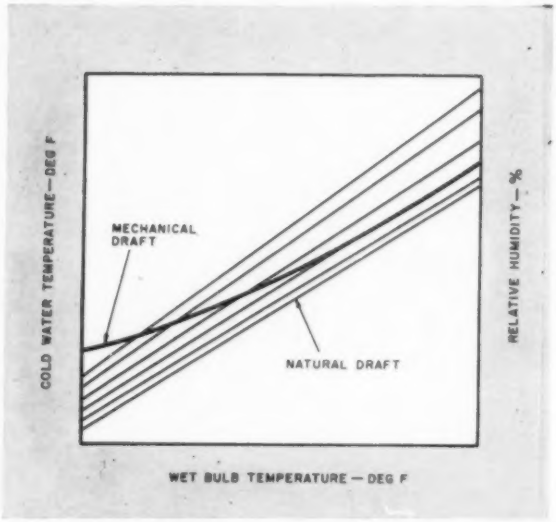


Fig. 3. (Above) Curves show the comparative performance of mechanical-draft and natural-draft cooling towers. Note the higher performance at lower wet-bulb temperatures

Fig. 2. (Left) Section of typical hyperbolic cooling tower. Open base permits entry of air, which is pulled up tower by the normal thermal air effect. No draft fans are required

heating and humidifying the air. Dependable operation is assured even at zero wind conditions, which is contrary to the familiar "blow-through" atmospheric tower. No moving equipment is required to create air flow; horsepower is used only for pumping, necessary in any cooling system.

3. Routine inspection and maintenance procedures necessary with mechanically powered cooling towers are not required. Inspections in some cases are scheduled on a semi-annual base, with no daily observation.

Performance

The designer of natural draft cooling towers must contend with a variable air rate through the tower. Except for this aspect, the heat transfer takes place within the tower wood filling much the same as conventional cooling tower designs. The hot water is distributed through radial piping over the filling area. It is cooled in its travel through the fill by direct contact with the air. The air flow results from the difference in density between the inlet and exhaust air — commonly referred to as the stack-effect. This points out the requirement for a design dry-bulb temperature that is expected to occur at the same time as the design wet-bulb temperature. The combination of wet-bulb and dry-bulb temperature establishes the inlet air density.

In general, the hyperbolic natural draft tower is at its best when the difference between the desired cold water temperature and the wet bulb temperature is equal to, or greater than, the difference between the hot water temperature and the cold water temperature. In cooling tower language, this would be an approach equal to, or greater than, the range. Investigation for a particular application may reveal that other conditions of range and approach are feasible and economical, in view of prevailing atmospheric conditions, or because of the physical advantages offered by the hyperbolic tower.

When comparing natural draft operation with other methods of water cooling, the cold water temperatures available throughout the year from each method must be carefully considered. This is necessary to assure that the economic comparison of water-cooling methods is on an equal basis. This aspect is of particular importance when comparing natural to mechanical draft water cooling.

The airflow through a natural draft cooling tower will increase during the cooler months of the year. This increase will offset the loss of heat transfer driving force at the lower wet-bulb temperatures. This loss cannot be offset in mechanical draft towers without increasing the air rate at the expense of using more fan horsepower. Comparison of typical mechanical-draft and natural-draft performance curves points this out. (See Fig. 3.)

Due to this difference in performance capability during the cooler months of the year, a re-examination of the design wet-bulb temperature, and the new aspect of relative humidity, may be warranted. An investigation of this will assure comparison on an equal basis.

The reinforced concrete hyperbolic shell was originated — and is still utilized — for its compressive structural properties. Thin wall design, usually between 4 and 5 in. thick, is employed. This design conserves material and makes possible the large towers being designed today. The largest size tower yet designed is installed at a British Power Station and is 260 ft in diam and 340 ft high.

Conventional reinforced concrete design practices are employed for foundations, cold water basin, and grillage support for the interior treated wood filling and eliminators. A ring beam at the base of the hyperbolic shell transmits loadings from the shell to inclined concrete columns, which are located around the perimeter of the tower. Maximum soil loadings of 4,000 psf can be accommodated with normal foundation design. (See Fig. 2.)

Economics

Hyperbolic towers are constructed at the proposed job site, using raw materials and labor from that area. Thus, to predict the evaluated cost in our country, on even a generalized basis, is difficult. However, when compared to other methods of water cooling (on a dollar-to-dollar basis), they can be competitive. Whether or not they will be competitive for a particular application will depend on a realistic evaluation of all factors. Long structural life, freedom from ground fogging and dependable operation are all plus-factors which influence the economic study.

For more information, write the Editor. Or, jot Hyperbolic Towers on inquiry card in this issue. THE END

Reviewing instruction tapes in engineer's booth at Richmond State Hospital's new power plant: Curt Dollins, head of Music Therapy Dept; Robert Brown, chief of power house engineers; Sheldon Moore, utility supervisor

Taped Talk Helps Operators Learn New Power Equipment

Instruction on tapes is a new wrinkle in training for power plant operation. It supplements—and humanizes—the instruction manuals, and serves as effective way to alert crews to operational pitfalls

By WILLIAM BRENIZER *

IN PREPARING this spring to start up and operate our new $1,100,000 steam generating plant (described in POWER ENGINEERING, October, 1957, pages 92–94) we were naturally concerned to find the best way of training our men in the proper use and maintenance of the new equipment.

We realized that the men had gained some knowlege of what to expect in the new plant, simply by being available and close at hand during the construction period. It was encouraging to note that many came back on their off-duty time to learn all they could during this period.

Using their eagerness as a base, we began instruction in the use of the new equipment and operation of the plant, on a man-to-man basis. When we felt that one man had absorbed all he could take for the time being, we shifted instruction to another, and so on until each man had some basic instruction.

We soon learned that our big problem was that too much time elapsed before we could get back for a second session with the same man. At this point, the head of our Music Therapy Department, Curt Dollins, offered his coöperation in using the tape recorder of the Music Department to tape instructions that could be played back to any one of the plant employees, or to all of them in a group meeting, at any given time. This would enable us to give a man additional training as he was ready for it, as well as provide a refresher session for the entire group.

We realized that the people best qualified to give instruction on maintenance and operation of the various equipments were either the manufacturers' representatives or their installers. We found that these men were most coöperative and open to the idea, and at our request gave freely of their time and knowledge in actually making tape recordings at the Hospital, on the Music Therapy Department's tape recorder.

In making the tapes, the idea was not to supplant the usual comprehensive instruction manuals supplied by the manufacturers for their equipment, but to humanize the instruction by giving it an audible version; and also to create a way to alert the men's attention to trouble spots that could develop. The instruction manuals have remained as the "text" for the course, while the tapes are serving as "lecturer."

Here's a sample of the kind of thing the operator hears when he listens to the tapes. This happens to be a section of the tape made by the manufacturers' field man for the water softening equipment used in the new plant:

> These two tanks are filled with resinous material, 66 and 95 cu ft per unit. We have an expected capacity of 51,500 gal, or 1139 kg, between regeneration, based on 26 grain hardness of water using a 96-97 per cent brine solution when regenerating. These softeners are equipped with a turbine-type charging meter with a Mercoid switch that has a cam that energizes the switch every 350 gal of water that flows through the meter. This is transferred back to a signal counter in the unit control boxes. We have set those counters up for 130 count before they go into regeneration. The counter setting was originally to be 147; however, it is always best to set these counters a little lower until you have time to make sure that the softeners are still producing soft water before they go into regeneration. Reason is that if you allow a zeolite softener to over-run and go hard, it reduces the capacity of the zeolite considerably, in a short period of time. Therefore, you should always make sure that the softeners are not overrunning their capacity at any time.
>
> The maximum service rate for each unit is 227 gpm. However, with both units in parallel you can only expect to get about 375 gpm . . . etc.

Amazing thing about this whole project has been the willingness of everyone concerned to pitch in and work together to solve the many problems. Who would have thought that a Music Therapy Department would or could have played such a vital part in a power plant? THE END

* Business Administrator, Richmond State Hospital, Indiana

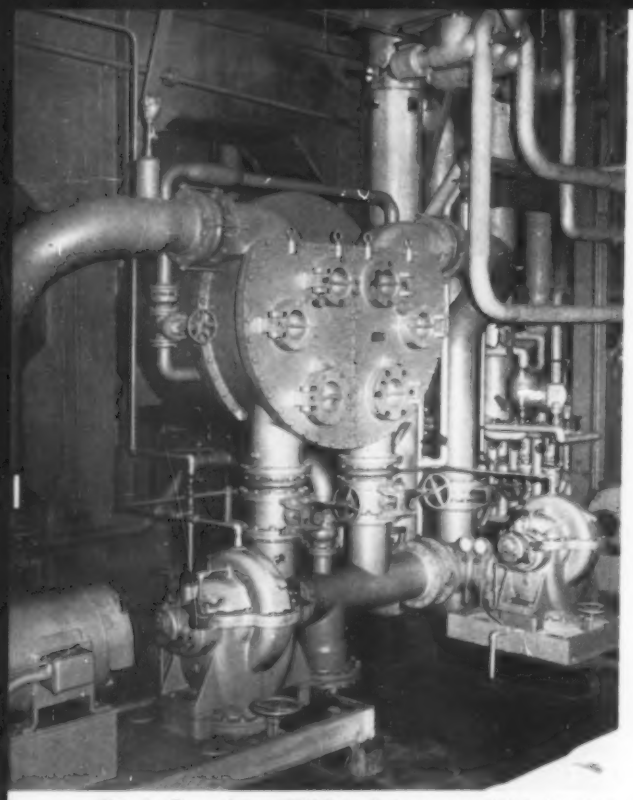


Fig. 1. One of two 5000-sq-ft two-pass divided-waterbox condensers in municipal plant at Lafayette, Louisiana

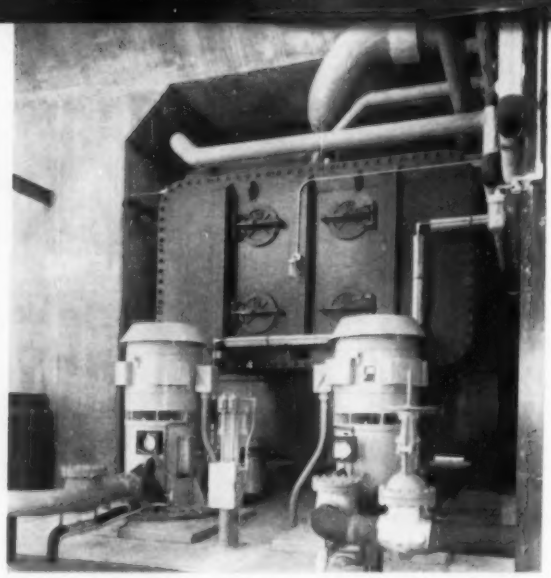


Fig. 2. Rectangular double-flow condenser at Texas Electric's Morgan Creek Station is designed for maximum deaeration

What's New in

Economies of space assume greater importance as power plant design grows ever more complex. Condenser manufacturers have been particularly flexible in making components fit available space.

TO THOSE power engineers accustomed to thinking of a condenser as a large, bulky object hanging below and affixed to a turbine exhaust flange, some of the pictures on these pages may come as a surprise. Yet, as one condenser manufacturer observed, they didn't just happen. Each installation pictured was the result of special-application engineering to produce a surface condenser that would fit within a rigidly defined area, unconventional as to size or outline. Further, this had to be done without the costly necessity of changing normal arrangement of support columns or building steel, and with no sacrifice in efficiency or normal water velocity through tubes.

This is another tool used more and more by today's power designers to hold the line against the relentless cost spiral of new power plant construction.

Problems facing the condenser design engineer in cases involving low headroom and, in some instances, no

Fig. 3. Half of twin-shell side-mounted condenser installation at Kaiser Aluminum's Chalmette, Louisiana, works

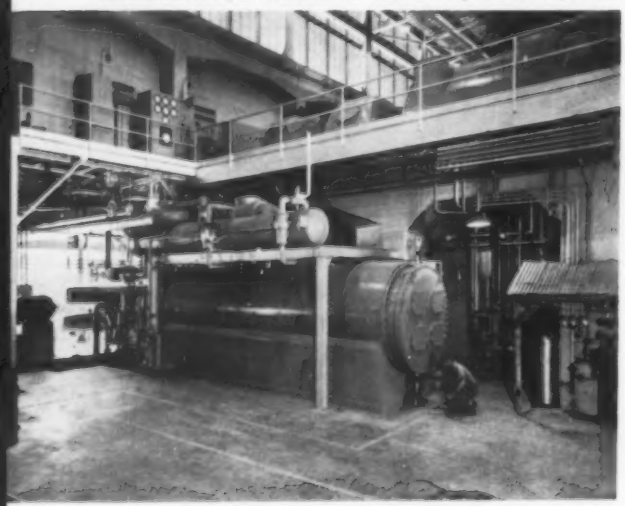
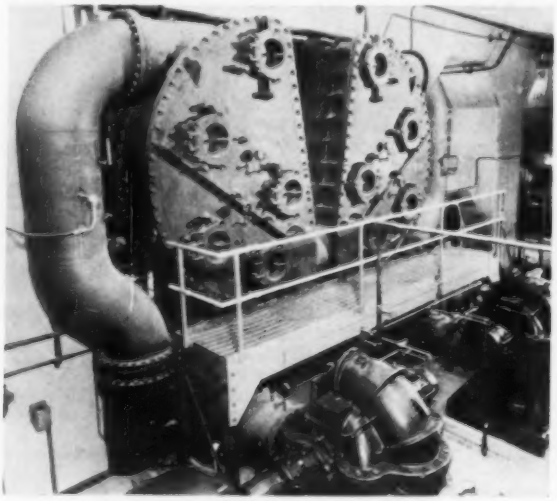


Fig. 4. Low-headroom, 30,000-sq-ft divided-waterbox condenser in Pennsylvania Electric's Warren Generating Station



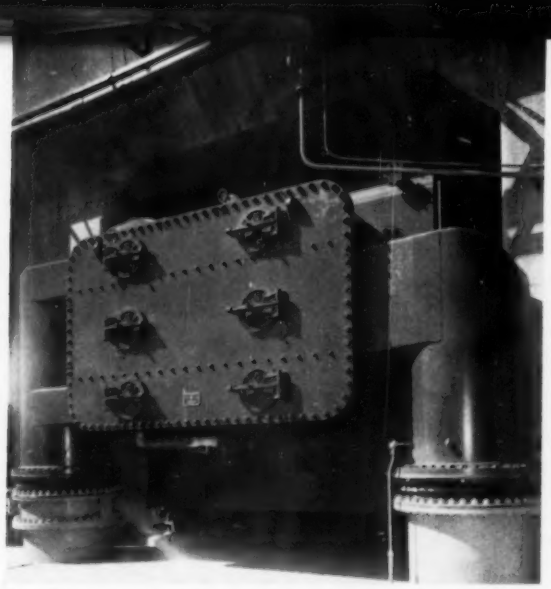


Fig. 5. Opposed end view of Fig. 2. Note how design conforms to that of foundation columns, a valuable saving in space

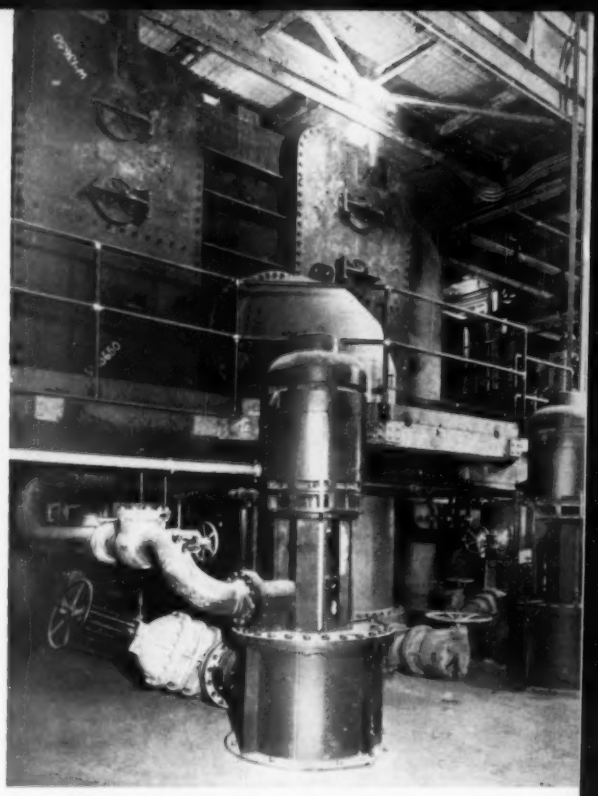


Fig. 6. Omaha Public Power District's 55,000-sq-ft reverse flush condenser is rectangular divided-waterbox design

Condensers

Rigid design concepts go out the window as new condenser shapes result in plant economies inherent in new designs. Here several recent installations point up the constantly changing scene

headroom whatsoever, are manifold. An ingenious solution to this latter problem is represented in Fig. 8, an installation in an oil refinery.

Space limitations almost invariably determine tube length. With this dimension inflexibly set, the designer must still cope with the problem of equal steam distribution over all cooling surface, preservation of maximum deaeration characteristics of the unit, maintenance of water velocities through tubes within acceptable limits, and accomplishing all this without significantly raising power requirements for pumping circulating water. That this successfully has been accomplished and, in a great number of cases, actually resulted in plant economies inherent in the new design is a great tribute to the fresh thinking and flexible approach to new problems by those in the field of condenser manufacture. There are other areas in the power equipment field that could well profit by the application of a similar approach. THE END

Fig. 7. One of five low-headroom oval-type 100,000-sq-ft condensers serving the 215-mw turbine-generators at Kyger Creek

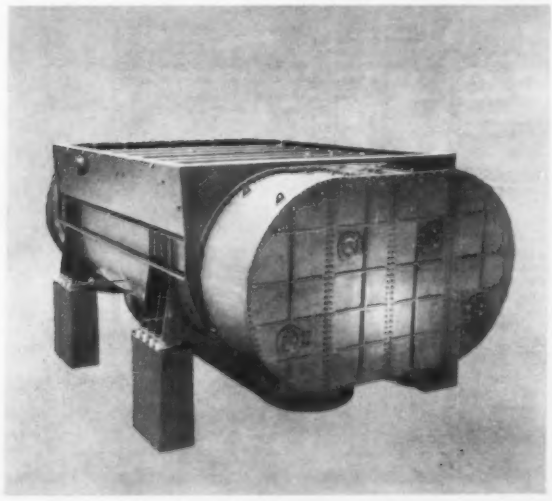
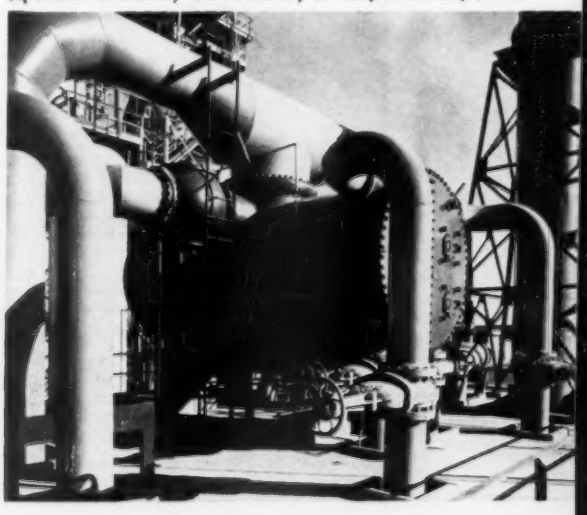


Fig. 8. Unusual application is this remote-mount 10,000-sq-ft unit at Sunray Oil's refinery in Corpus Christi, Texas



Waste and Water Systems Cut Cost at Atlantic

Savings in construction and subsequent operation run into millions when water is cooled, treated and recycled in this closed system

By R. G. MERMAN* and E. R. ROTH†

WATER USAGE per gallon of crude processed at less than 25 per cent of the industry average indicates the extent of the water conservation efforts of The Atlantic Refining Co. In addition to water conservation, these efforts have resulted in substantial economies in water-pollution-control activities, and have improved heat transfer and corrosion control in cooling systems.

Water conservation practices of The Atlantic Refining Co illustrate what industry is doing to answer both waste-disposal and water-shortage problems. Although the water conservation program at Atlantic was initiated to reduce the quantity of waste water to be treated at both its Philadelphia, Penna, and Port Arthur, Texas, refineries, it has proved valuable also in the control of cooling-water quality.

Likewise, it has been of direct benefit from a water-conservation viewpoint during recent periods of water shortage in Texas. The possible existence of critical water shortage in the future may or may not be real, depending on how well industry practices water conservation. Conflicting opinions are noted in the literature.

Waste Treatment

As part of the stream pollution abatement program at the Philadelphia refinery, Atlantic, in 1953, placed in operation a 10,000,000 gpd waste-treatment plant. The plant consists of a gravity-differential-type grit-and-oil separator, followed by chemical coagulation and sedimentation. Sludge resulting from chemical treatment is dewatered and incinerated. The heat content of the sludge is recovered as steam.

Purpose of the plant is to remove oil (free and emulsified) and a substantial percentage of the biochemical oxygen demand (bod) from waste waters originating in the major operating yard of the refinery. In sizing the treatment plant, every effort was made to remove clean water streams from the sewers. Cooling towers were provided at a cost of $1,250,000 to reduce once-through cooling-water requirements by 21,000,000 gpd. The reduction in waste-treating costs resulting from this expenditure is estimated to be about $2,000,000 in construction cost and $300,000 annually in operating cost.

From a water conservation viewpoint, use of cooling towers allows maximum use of water for cooling — surpassed only by use of air-cooled heat-exchange surface. Wherever possible, cooling-tower water systems are bottled up and only sufficient blowdown is practiced to maintain a maximum cycles-of-concentration of 3 to 4. Use of cooling towers also allows economical treating of the recirculated water to control corrosion, scale, and biological slimes.

Chemical Treating

Atlantic operates 41 cooling towers at its two refineries and has developed a successful chemical treating and control program. Treating costs per 1000 gpm recirculated are on the low side of the range shown for the industry ($1.00 to $5.00 per 1,000 gpm recirculated).

Chemicals used are chlorine and Calgon (sodium hexametaphosphate).

* Sanitary Engineer, Power Section, Manufacturing Dept, and † Section Head, Industrial Waste Engineering Section, Research and Development Dept, both with The Atlantic Refining Co

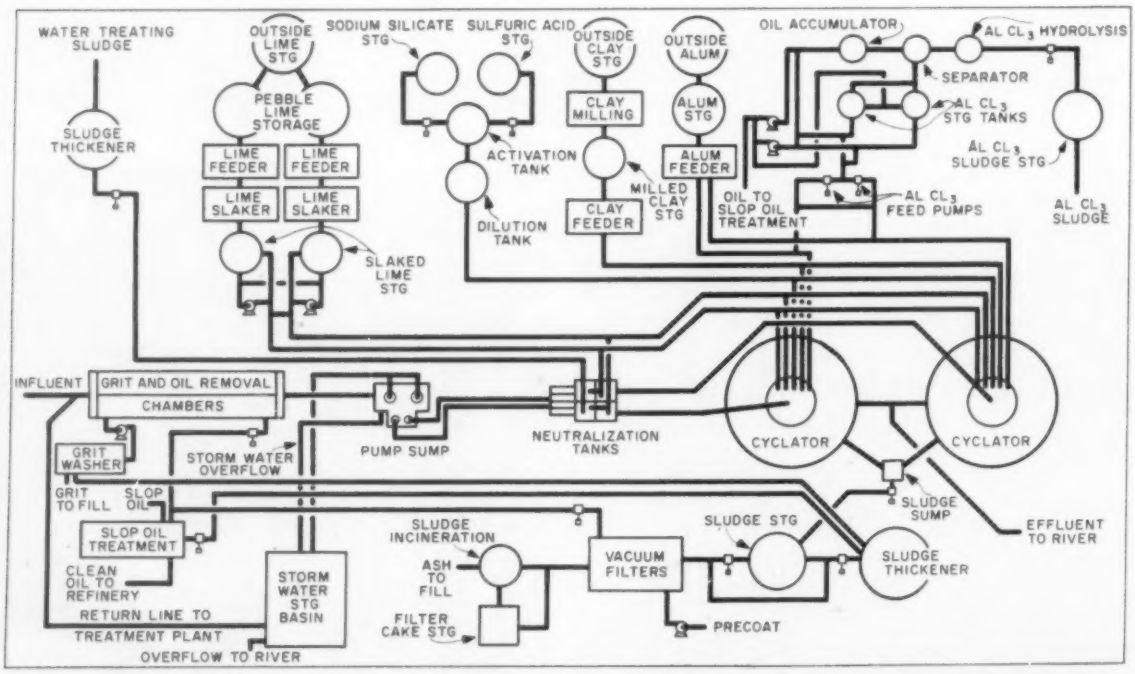


Fig. 1. Simplified flow diagram of Atlantic's 10,000,000-gpd chemical-flocculation waste-treatment plant at Philadelphia

Fig. 2. Waste-treatment plant, with cylators in foreground

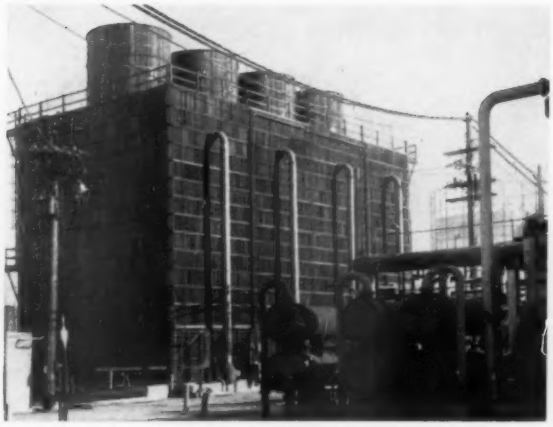


Fig. 3. View showing one of the cooling-tower installations

Chromate is also added at some towers. Chlorination practice calls for slug addition on a once-per-day or once-per-shift basis, and maintaining a chlorine residual of 0.5 to 1.0 part per million for 10 to 20 min. Both Calgon (as meta) and chromate are held at 10–12 parts per million. Optimum pH is 6.8 to 7.2 at controlled alkalinity.

Cooling water quality is controlled by operating personnel at each process unit. Simple test kits have been developed for field determination of pH, chlorine residual, phosphate, and chromate. Methods employed for these determinations are colorimetric. A simple conductivity meter is used to check the cycles of concentration.

Control Methods

On the basis of these control tests, the operators adjust the chemical feed rates and blowdown rates to maintain water quality within designated limits. Inhibitors are added batchwise. Chlorine is fed by program-controlled solution-feed chlorinators using liquid chlorine.

Caustic-feeding equipment operates simultaneously with the chlorinator to correct for the acidity of the chlorine. Batch additions of sulfuric acid are made as required to maintain the pH and alkalinity at the desired level.

Operating levels of pH, inhibitor, chlorine, and cycles of concentration are established by consideration of heat exchanger fouling and corrosion (both steel and copper). The desired pH level varies seasonally with the quality of the make-up water. Likewise, higher chlorination residuals are sometimes required on certain units in the summer as biological growth rates increase.

Effectiveness of the water-quality-control program is determined from time to time by the use of test coupons. For this purpose, test pieces are placed in hot tanks preceding the towers and in the lines to measure corrosion under both static and dynamic conditions. In some cases, provisions are made for the removal of short, prepared test sections of pipe for examination at times of shutdown.

Control of biological slimes has been shown to be important in over-all heat-transfer rate — particularly for relatively low boiling point hydrocarbon service. Comparative tests demonstrated that a decrease of 20 to 30 per cent in over-all heat-transfer rate resulted without chlorination. Scale is successfully controlled and corrosion rates (total metal and pitting) are held to extremely low levels.

Present water usage at the Philadelphia refinery is given in the table. A general conception of the effectiveness of the cooling-tower program may be gained by comparing water usage with known usage in the petroleum refining industry. Water usage of four gal of water per gal of crude processed compares favorably with reported averages of 17 to 18 gal of water per gal of crude. Minimum and maximum refinery usages are variously reported as 1.7 to 7 and 30 to 44.5, respectively.

Savings

If water for cooling were to be supplied on a once-through basis today, considerable additional equipment investment would be required for pumping, chlorination, and diversion sewers. Assuming a 35-degree temperature rise, the total costs for once-through cooling water would be about twice current costs for tower cooling. Water for cooling is the major refinery use as noted in the table, and the indicated saving is appreciable.

Water conservation is a continuing effort. Current projects include bottling up of older tower systems where uncontaminated water is discharged to the sewer, and maximum utilization of process water. The latter effort includes such practices as recycle of condensed stripping and vacuum jet steam back to water make-up to crude desalters. Also, changes in petroleum-product treating processes have eliminated or greatly reduced the amount of wash water required. THE END

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Tabulation of water usage, which amounts to four gallons per gallon of crude

Distribution of Industrial Water Supply
Philadelphia Refinery, Atlantic Refining Co

Use	Quantity—mgd*
Cooling—includes 2 mgd* hot return water diverted to boiler feedwater	27
Process	2.5
Boiler feedwater—excluding 2 mgd* from cooling systems	1.5
Total Industrial Water Supply	31.0

* Million gal per day.

PVC Blower . . . corrosion-resistance is just *part* of the story

Light in weight, PVC blower requires far less structural support, is well adapted to handling flammable vapors

SINCE the plastic material polyvinyl chloride (PVC) appeared on the American scene, it has made a name for itself in industrial applications where corrosion-resistance is an important consideration. Many a power engineer can testify to the value of PVC tanks, piping, valves and fittings.

It is perhaps not so well known that PVC also has the ability to remain stable in the presence of most chemical fumes and vapors, particularly the high-oxidizing acids and alkalies. This characteristic, combined with light weight (specific gravity of 1.41) and ease of fabrication, has led to the development of the PVC blower.

PVC blowers are being used in outside locations subject to varied weathering conditions; inside plants where condensation and moisture contribute to corrosive action, and in areas of chemical processing where the resulting fumes corrode and decay highly-susceptible metal equipment.

Non-sparking, dielectric properties make the PVC blower especially well adapted to the handling of flammable vapors (spray booths, dip tanks, chemical distillation, etc). PVC's high glossy, non-porous surface results in a reduced frictional loss for air flow, and hence a more efficient flow of air through the blower. Also, it facilitates the radial movement of air across the blades, increasing centrifugal action. Similarly, the build-up of residual matter is kept to a minimum.

PVC is rated very high in its adaptability to design and manufacture. It can be worked in a number of ways: heat-formed into a variety of shapes (cylindrical, conical, and other oblique forms); machined and finished with standard shop equipment, and held to close tolerances; and precision-welded — an operation that ranks with the foremost developments of the industry.

An example of PVC's functional utility is the specially designed driveshaft seal in the PVC blower. Positive protection is provided for the shaft and other metal drive parts exposed to fumes within the housing.

Use of PVC has made possible a number of new features in blower design. PVC impeller wheel, for instance, gives a pronounced reduction in turbulence, improved laminar flow over the spinner and wheel hub, and a greater distribution of air over blade surfaces. This produces greater volume of air flow (cfm per developed brake-hp).

One characteristic of the PVC blower, however, has not been without criticism — namely, the 140 F recommended maximum temperature for operation. As explained by Robert C. Bowker, of Industrial Plastic Fabricators' research department: the indicated 140 F applies specifically to the region of air at the blower itself. Bowker reports that a number of tests have revealed that only under extreme circumstances could such a high temperature occur in this area. Even with a tank temperature of 212 F, the exhausted fumes cool considerably, due to mixture with ambient air, and the velocity of air flow in the duct.

In fact, during a series of actual tests, the temperature was lowered to less than 120 F while still in the riser duct of the tank hood. Further cooling takes place during the travel through the rest of the system of the blower. This cooling action is true of all systems with open or part-open hood design.

If you would like to have more information on PVC blowers, or on Bascodur, the new plastic described below, just write The Editors, or use the inquiry card to be found elsewhere in this issue. Simply write Plastics on the bottom of the card.

Bascodur . . . another new plastic for the power field

NOW ANOTHER "miracle" plastic has come along which holds great promise for power engineers. As compared with PVC, this new material has a much higher temperature rating. Although it is not yet being produced in this country, some products made with the material have been in use here for some time.

The new material is called Bascodur. It is a thermo-setting material which was developed by Badische Aniline and Soda Fabrik in Germany about five years ago.

Bascodur is the first thermo-setting material to be extruded perfectly into pipe and other forms. The pipe has a glass-like finish inside and out. It has a specific gravity of 1.75. The material will handle up to 375 F. Generally speaking, it will handle almost all organic chemicals except two or three, and these are in the amine family.

It handles almost all inorganics. One of its greatest accomplishments is its ability to handle hydrochloric acid at 300 F with no effect whatever.

Thermo-setting materials act differently than thermo-plastic materials. On a thermo-setting material, such as Bascodur, as the temperature increases there is no loss in pressure, as it remains rigid and does not change until it passes 375 F.

Bascodur is made in the form of fittings, pipe, sheets, and extruded shapes. Material can be cast easily into a tank or heavy plates for pump bases, etc. The pipe can be made in a semi-cured condition, shipped to plants where it can stay on the shelf until ready to be processed into heating coils or cooling coils.

The coefficient of the thermal conductivity is equal to that of Monel. It can be molded easily by compression molding, and is an excellent machinable product. Pipe and fittings are put together with Bascodur cement using socket-type fittings. Adiabatic towers are manufactured from this material for the chemical industry.

Pumps and valves are lined with Bascodur by a method called intrusion. Parts of the pumps are naturally molded. All of the metal work is protected by the intrusion of Bascodur.

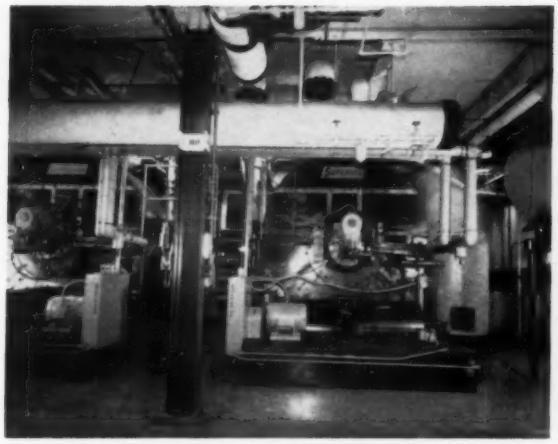


Fig. 1. View of twin-package oil-fired steam generators with the burners, motors, controls and combustion sequence lights

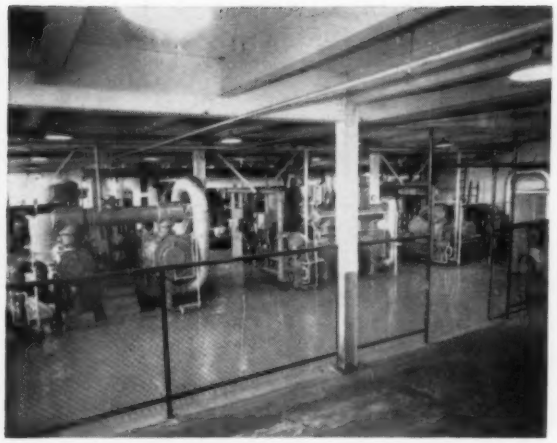


Fig. 2. General view of modernized engine room at Dana Corp's Pottstown Div plant. Air compressors are seen in foreground

Packaged Boiler Automation Pays Off as Dana Corp Streamlines Plant

Modernization of plant by cost-conscious manufacturers does not stop with production facilities. Dollars saved by improved manufacturing technique can be matched by modernizing your steam plant

By HAROLD L. BECKER*

POTTSTOWN DIVISION of Dana Corp, where automotive and aircraft universal joints and drive shafts are manufactured, is now approximately at the midway point in an extensive plant-wide modernization program which, at its outset, was planned to be completed in five years. Several years of study preceded the actual start of the program.

Numerous basic changes have already been made, not only in machines and manufacturing methods, but in steam generating facilities as well. The conversion has been to an automatic package-type system located within one of the plant buildings that has, since its inception, resulted in many benefits to the operation of the Pottstown Division.

Installation of our two package-type oil-fired steam generators, operating at 115 psig with a combined capacity of 40,000 lb per hr of steam at 212 F, was completed in time for the start of the Fall heating season. Installation of this modern system was the outgrowth of a very detailed steam survey.

Formerly the plant consisted of two fire-tube and one water-tube coal-fired, stoker-fed steam boilers located in a boiler house separated from our several plant buildings. A fireman was in attendance around the clock, seven days per week.

Manual controls on the feedwater and condensate return system along with the coal elevator and stoker required excessive skilled trade maintenance. Rail shipment costs of coal further increased the expense of operating the old steam plant.

Headaches of Obsolescence

Because of the incompatible operating characteristics of the three boilers involved, it was extremely difficult to maintain proper water treatment within the boilers, steam lines and condensate return system. Specifically, steam survey findings were:

A. Plant steam demand varies from 10,000 lb per hr in summer to 35,000 lbs per hr in winter.

B. The old system required the services of a fireman 24 hours a day the year around. The proposed oil-fired system would require a fireman in attendance four hours a day, seven days a week during the winter, but would not require attendance Saturdays and Sundays during the summer.

C. The old system required skilled trade maintenance averaging four hours per day. Maintenance of the proposed oil-fired package units was estimated at one-half hour per day.

D. The stoker-fed, coal-fired units were either over-fired or under-fired with relation to the immediate steam demand. Because of the manual controls on all factors affecting combustion efficiency, the firing rate of these boilers could not follow the steam demand. The automatic and electronic controls on the proposed package units would instantaneously adjust for changes in steam demand to maintain a much improved combustion efficiency.

E. Since the Pottstown Division was developed through various building stages over a period of years, steam service was supplied to buildings covering 500,000 sq ft of floor space by merely carrying extensions from existing piping. When the survey was started many sections of the steam supply and condensate return within the plant were found to be undersized, resulting in pressure drop and, in some cases, flash condensation within the steam lines themselves.

As a result of the survey, the entire steam supply piping was re-designed and the main supply line properly sized and extended from the proposed boiler room to all sections of the plant. Process steam piping was extended from the steam mains to departments presently requiring this service. Blank tees were provided in the line for future extension as plant expansion may require. The plant was divided into zones for heating purposes with each zone being supplied from a pressure reducing station maintaining heating steam at 25 to 30 lb.

F. Due to the various design operating pressures of the three coal-fired boilers, the feedwater treatment was extremely difficult to control with the old system. The proper additions to

*Engineer, Dana Corp Pottstown Div

one boiler to control priming and foaming was not the proper addition for the same feedwater for the other two boilers on the line. It was discovered that feedwater treatment in excess of the normal was creating a great deal of maintenance work resulting from carry-over of chemicals into the heaters, traps, strainers and condensate return lines. In the proposed new system, a central water softener, chemical feed pump, and deaerator would provide a balanced make-up for the twin package units.

G. At the time of the survey the boiler house was remotely located in relation to the plant air compressors, emergency fire pump, and d-c generators. It was desirable to relocate all the services into one area so that routine maintenance such as lubrication, electrical checks, and general supervision of these services could be performed with less travel time. The secondary purpose in centralizing these services was to provide localized control of this machinery in the event of electrical power failure.

The steam generator installation has successfully provided the anticipated results. Periodic calorimeter checks at the boilers and the other sections of the steam main indicate a minimum steam quality of 99.5 per cent. Boiler water samples and condensate samples are analyzed twice weekly and feedwater treatment quickly responds to variations in additions of the water treatment system.

Chemical additives to the make-up water now comprise only 30 per cent of that supplied to the old boiler system. CO^2 content of each stack, evaporation rate of each boiler, return pressure at each boiler header, boiler feed pump pressure, and fuel consumption are constantly recorded on time graphs. These charts are reviewed daily by supervision and permit immediate corrective action to either or both units as required.

Positive Back-up a Factor

To meet maximum demand at the height of the heating season, both boilers are on the steam line in accordance with the following sequence: The lead boiler maintains full firing rate at any pressure below 115 psig. The second cuts in the line at 110 psig and modulates its firing to maintain a steam main pressure between the lower limit of 110 and the upper limit of 115 psig.

During the non-heating season both units are on the line as a precautionary measure inasmuch as the boilers are unattended 80 per cent of the time. If one should fail, the second automatically picks up the load until such time as the failure is corrected.

Due to the long lay-over between firing periods for the second unit, each boiler is equipped with a float-controlled, high-water shut-off valve to eliminate any possibility of a leaking valve in the make-up system flooding the steam main.

Boiler water temperature controls keep both boilers at proper steaming heat so that either may step in and pick up the load in case of failure of the other unit. Automatic water feed controls are installed to maintain both at the proper operating water level, so that both boilers are instantly available for full operation.

As previously pointed out, this installation is unattended 80 per cent of the time, and due to the degree of automation built into this steam plant, a failure of an automatic control on the combustion sequence of feedwater supply will shut down the generator.

Three sets of lights and buzzers are installed in strategic locations within the plant to indicate low steam pressure so that the failure can be given immediate attention. A secondary set of control lights are installed on the control panel of each boiler. These lights are coördinated with the firing sequence so that the maintenance personnel can tell at a glance at what stage the firing sequence failed, thus limiting the trouble-shooting required in locating such failures. THE END

Commutator Plating With Rhodium Reduces Wear and Static

A NEW METHOD of rhodium-plating commutator segments has been developed which prolongs the life of electric motors, while at the same time eliminating radio interference and reducing power consumption. The procedure is particularly advantageous because it is fast and inexpensive, and because commutators may be treated without having to immerse the entire armature in a corrosive plating solution. Thus, Dalic plating avoids the danger of damaging the windings.

Only one major piece of equipment is needed for such plating: a special rectifier with a finely graduated voltage regulator, permitting close control of the plating current. A lead from the rectifier, the cathode, is clamped to a small lathe in which the armature is rotated. The other lead has a special plating stylus, fitted with a pure graphite anode. The latter is wrapped in cotton, and dipped in the proper plating solution. With the current on (the output voltage for this application is 12 v dc), the wet anode is swabbed over the area to be plated, and immediately highly cohesive, non-porous deposits of metal are obtained. Thickness of deposit depends directly on plating time and current, indicated precisely by a finely graduated ampere-hour meter on the rectifier cabinets.

Electric fuel-pump motors for interceptor planes were causing manufacturing delays, because they would not deliver enough fuel when drawing the maximum allowable current. It was found that the rapid formation of a copper oxide film on the commutator segments increased the contact resistance, to cause arcing, excessive brush wear, a high working temperature, and a greater power load on the aircraft. Also, after as little as 120 or 130 hours, wear was noticeable.

To find a way of avoiding these losses, the commutators of one motor were rhodium-plated, but not those of a duplicate control sample. Commutators in this test were 1.25 in. in diameter, and had 24 copper segments, each 0.75 in. long, with a 0.025-in. gap between adjacent bars. Thickness of rhodium deposit was 0.00005 in., although later trials revealed that half this was enough.

Improvements in performance were noted at once. After 385 hours of continuous operation, the armature current under load is up to 12 per cent less for each pump.

Some unexpected side-benefits were also discovered: 1. Temperature of the plated commutators was 464 F, as against 572 F for the unplated commutator; 2. wear was reduced, from a former value of 0.030 in. after 168 hours, to no measurable wear after 600 hours for the plated commutator; 3. **radio interference was eliminated** by rhodium-plating the commutator. Formerly, interference had meant removal of a rotary-converter from aircraft after about 300 hours. Rhodium-plated armatures allows the same units to stay in static-free operation for several thousand hours.

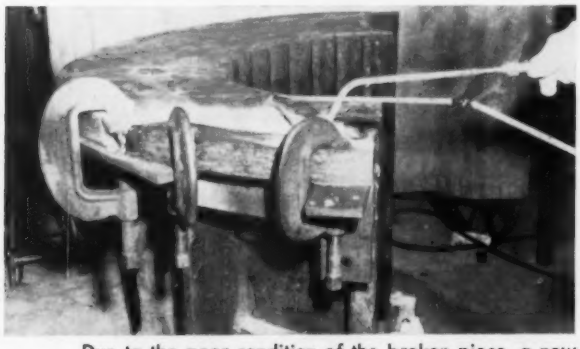
Three direct advantages of plating the armature are: 1, elimination of static and interference; 2, increased wear resistance; and 3, reduction in current required. These factors are particularly vital in aircraft and guided missile applications, where equipment must operate for extended periods with utmost reliability. Additional benefits accruing from the selective plating process are its speed, and the low cost of rhodium-plating a typical small armature. Time to treat the commutator bars: about 45 seconds. Cost: about 54 cents. This small investment in time and money results in a motor which will run five times as long, without burning out or overheating, and at considerably lower amperage.

For additional information write the Editor, or jot Rhodium-Plating on the enclosed inquiry card.

Large Hydro Bearing Repaired On Job By Flame-Welding

1 View showing the main fractured piece from the flange of bearing. This had been previously arc-welded with older type cast-iron electrode method

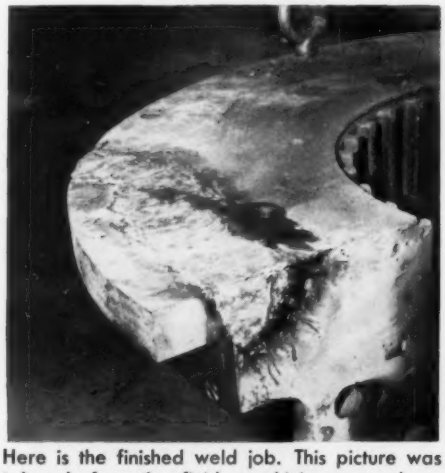
2 View showing break on the bearing, after faulty metal had been cut away. Metal was chipped out to give angle of approximately 30 degrees, for weld



3 Due to the poor condition of the broken piece, a new piece of cast iron was shaped to fit into the flange. Note use of C-clamps with the steel plates below

4 Preheating was done locally near the area to be welded. Steel studs, inserted to assist in the weld bond, were preheated to a dull red heat

5 To prevent rapid chilling, asbestos powder was distributed over the complete weld job, which was then wrapped with heavy asbestos cloth



6 Here is the finished weld job. This picture was taken before the finish machining was done. There was no evidence of cracks or distortion

How Automatic Controls Apply To

Design of instrumentation and controls depends on many factors

By E. A. STRAHLENDORFF*

WATER TREATMENT processes can be divided into three groups — ion exchange processes, chemical processes and mechanical processes. All these types of treatment can be effectively automated and mechanized with standard components to give the advantages of dependable, simple operation, plus minimum labor, maintenance and chemical costs.

Controls and measurements needed to automate boiler feedwater treatment are similar to those used in the manufacturing or process industries. They include quantitative measurements of liquid flow rate, liquid volume and dry chemical weight; physical measurements of level, pressure, temperature and time; and chemical measurements of conductivity, pH, total hardness, silica, free mineral acidity, oxygen, carbon dioxide, iron and turbidity.

This discussion shows how automation has been applied to the various boiler feedwater treatment processes and points out the type of equipment required, including controls, instrumentation and panelboards.

Ion Exchange Processes

Demineralizers. Demineralization has found widespread use in the treatment of boiler feedwater. While it is the most complicated of the water treatment processes, it lends itself easily to automation.

In a manual demineralization plant, all operations are controlled by hand-operated diaphragm valves. The need for regeneration is signaled by a simple integrating meter or by a conductivity meter. Introduction of acid and caustic is handled by either positive-displacement pumps, centrifugal pumps or ejectors, but control is obtained by hand-operated valves with the aid of rate-of-flow indicators.

In a large plant requiring more than 100- to 200-gpm capacity, or in a three- or four-bed demineralization system, manual control becomes difficult and automatic operation is often desirable. A typical plant of this type treating 1600 gpm is shown in Fig. 1. Each cation unit contains a nest of individual air-operated Saunders-type valves controlled by a single sequence-cycle timer. A transmitting flow meter on the inlet to each exchange unit gives local flow indication and also transmits to a recorder-integrator located on the panelboard.

Cation Regeneration

Cation regeneration can be initiated by any one of several methods. When the supply is of a constant composition, as in the case of well water, a totalizing meter with contactor is sufficient. A variable supply, such as many surface waters, may require a series of electrode probes within the cation unit to compare conductivity at several points within the bed or to compare the conductivity at a single point within the bed with the conductivity of the effluent.

*Graver Water Conditioning Co

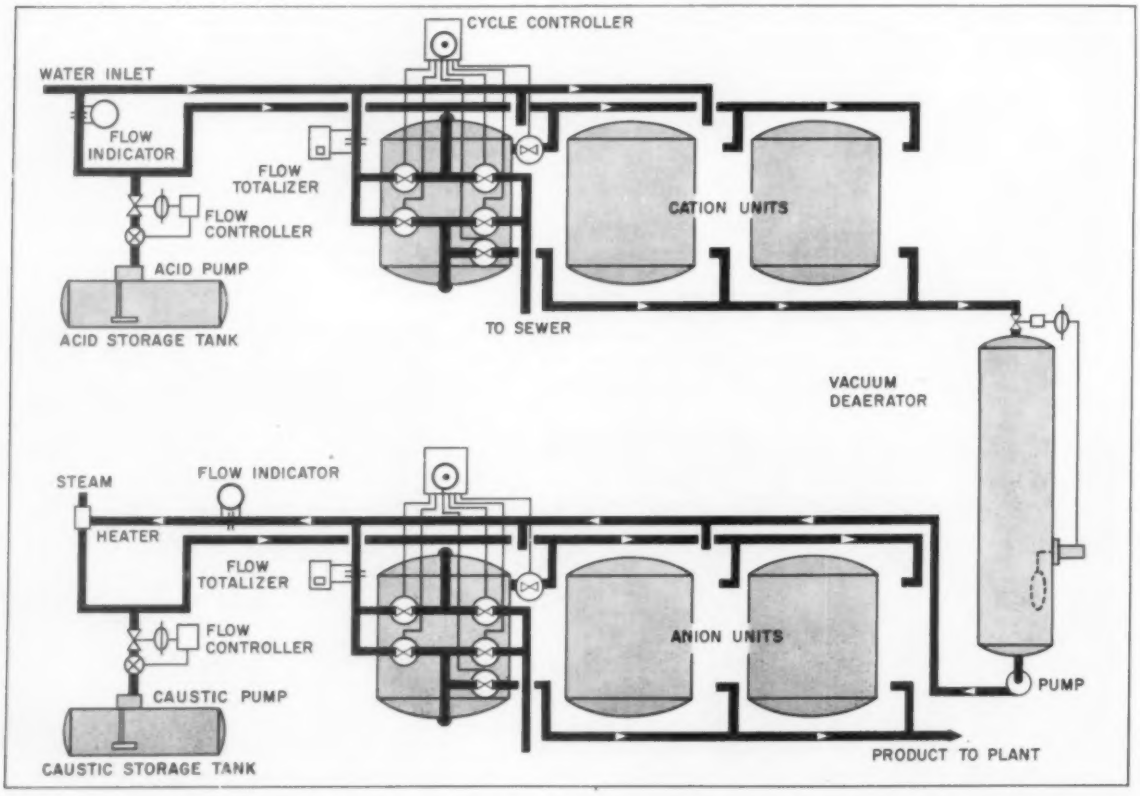


Fig. 1. Flow diagram of automatic two-bed demineralizer system. Units on right are identical with those with controls shown

Feedwater Treatment Systems

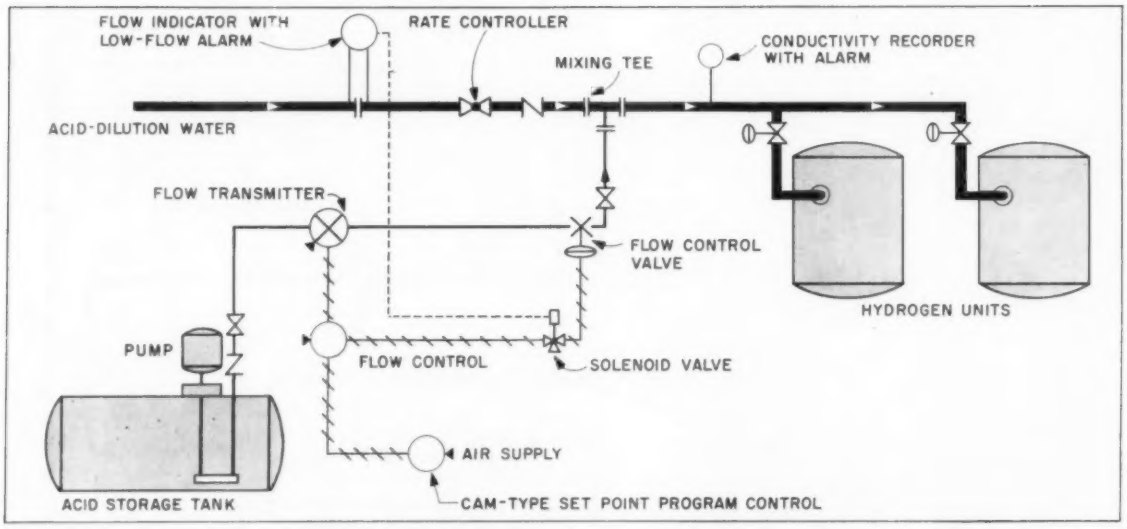


Fig. 2. Control scheme for a progressive acid-regeneration system. Acid flow is increased either gradually or in steps

Difference in conductivity between two points indicates when the bed is near exhaustion, thus protecting the anion bed from cation breakthrough.

Another indication of cation exhaustion is measurement of a drop in free mineral acidity with a pH meter. A combination of two or all three of the above methods can be and often is used in the modern demineralization plant.

Today, sulphuric acid regeneration is generally accomplished by a stepwise method as shown in Fig. 2. Acid is pumped from a storage tank through a flow indicator totalizer and a throttling valve to the mixing tee. The throttling valve is automatically set to gradually increase the amount and strength of the acid fed to the system either in distinct steps or gradually between preset levels. Dilution water is fed to the mixing tee at a constant, controlled rate.

Oxygen and carbon dioxide are removed from the cation effluent in a vacuum deaerator. A displacement-type level controller in the vacuum deaerator storage tank governs the operation of the air-diaphragm inlet valve. Water is pumped from the vacuum deaerator through the anion units.

Anion Regeneration

Instrumentation for the anion exchangers is similar to that used for the cation units. Anion regeneration can be initiated by any of the following methods.

1. Volume by means of a totalizing meter.
2. Rise in conductivity as measured by a conductivity meter.
3. Rise in silica measured by manual methods. (Automatic silica recording is now being introduced as a feature of large, complicated demineralization plants.)

A combination of the first and second methods is generally used, with the third method reserved as a check.

Regeneration of the anion units with sodium hydroxide is controlled similarly to acid regeneration except that caustic is fed at constant strength. Also, dilution water must be heated so that the temperature of the dilute caustic within the anion exchanger is approximately 100 to 110 F. Thus, rate of flow control and recording devices are used on the caustic and dilution lines and a source of heat is incorporated, this source being automatically controlled by the temperature of the diluted regenerant.

Although the demineralizer can be designed for fully automatic control, most users prefer that an operator actually push a button to start the regeneration sequence. Sometimes he also returns the units to service by manual initiation. The advantage here is that the operator is on hand to check the critical regeneration operation. After regeneration the units will operate from 8 to 24 hr or more without interruption.

Alarms are usually incorporated in demineralizer design to cover all key measurements such as conductivity, water levels, and pump operations. A regenerated unit does not return to service until it passes an automatic conductivity check at the end of the normal rinse. If conductivity is not at the proper level, the unit is given an additional rinse. If this does not correct the high conductivity condition, the unit is taken off the line and an alarm rings calling the attention of the operator.

Units can also be designed to rinse during service operation if a temporary breakthrough of conductivity occurs before the expected end of the run. Multibed plants that are fully regenerated and in stand-by position are automatically given a short rinse to remove any leached out solids before they are placed in service.

New Silica Control

For demineralizers treating boiler feedwater, silica removal and silica end-point control is most important. Conductivity and volume control do not always correlate with silica end point and frequently manual quantitative tests for silica near the end of the run must be made.

A recent development in automation which offers promise here is the automatic dissolved-silica analyzer and recorder. It works on the well-known analytical principle of forming a silica-molybdate complex with subsequent development of a more intense molybdenum blue color by means of a reducing agent.

The instrument provides for sampling of the demineralized water and the addition of necessary reagents in a time and order sequence. The sample is permitted to achieve maximum color development and is then passed to an automatic unit that records the intensity of light passing through the sample from a constant light-intensity source.

As high boiler pressures and temperatures become more prevalent, this analyzer will increase in impor-

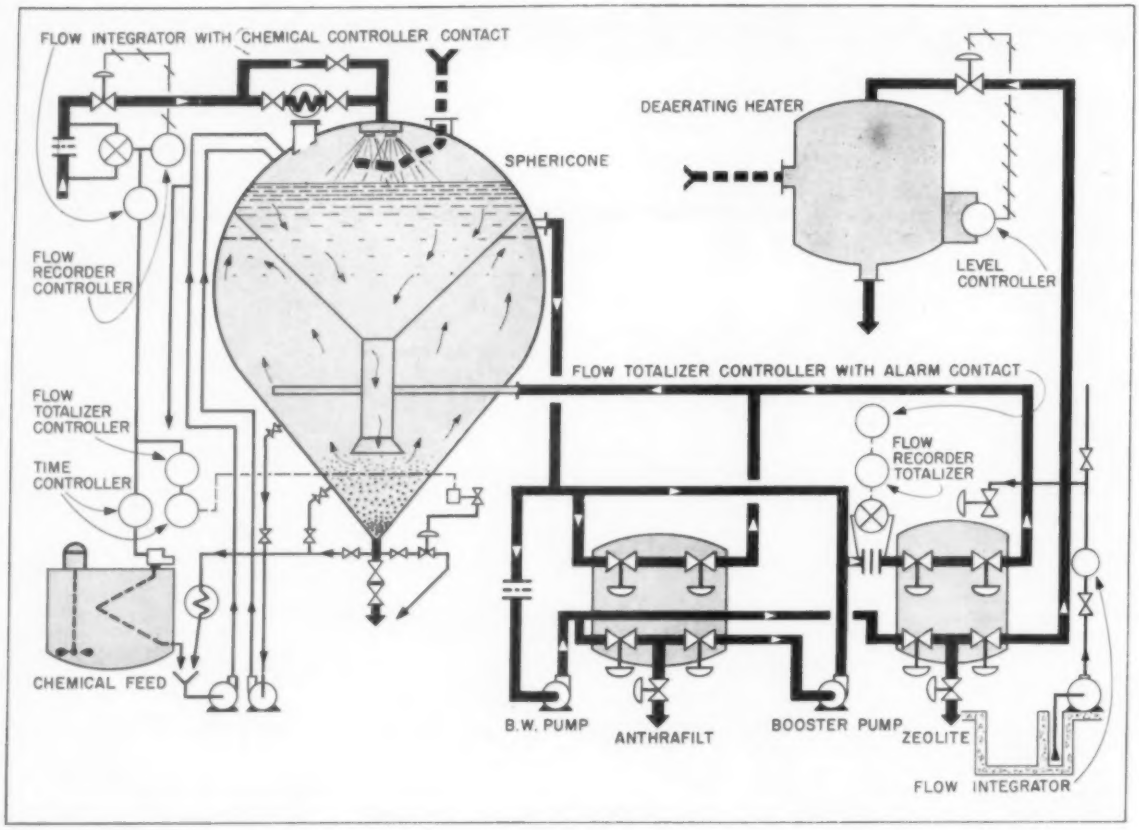


Fig. 3. Hot sedimentation-hot zeolite system with deaerating heater. Proportioning and brine handling are fully automatic

tance since the need for quick and positive silica end-point indication becomes imperative.

Chemical Processes

Hot Sedimentation-Hot Zeolite Softening. A plant of this design heats and softens water and also reduces solids, alkalinity and silica. Partial or complete deaeration can be incorporated. This system finds extensive application today in boiler installations running from 150 to 600 psig, and even as high as 900 psig.

A typical large automated hot sedimentation-hot zeolite plant is shown in Fig. 3. Inlet water flows through a meter and level control valve to the sedimentation tank where lime (standard hydrated or dolomitic) is fed and mixed with raw water.

Contact with magnesium sludge formed in the unit or added with the lime reduces the silica to values of less than 1 ppm. The water then flows by gravity to filters and is pumped through the zeolite softeners to a storage tank or to a two-stage deaerating heater.

Surges are handled by the level controller mounted on the hot process tank. The flow of chemicals is automatically proportioned in accordance with the raw water flow using the flow contactor on the inlet meter.

Both backwashing of the filters and regeneration of the zeolites are initiated by push-button or can be designed to proceed automatically. With fully automatic operation, the filters are washed when a fixed pressure drop occurs across the units or once every 24 hours, whichever comes first; zeolite softener regeneration is initiated on a volume basis.

Brine for zeolite regeneration is also handled automatically. It is pumped from a wet salt storage basin and metered as to flow and volume. Minimum operator attention is required in a plant of this type.

Chemical feed for lime, or other required chemicals, may be either of the wet-decanting or the dry-volumetric type. Chemical feed rates are controlled proportionately to raw water flow by timers.

In smaller plants, the chemical storage bins or hoppers are filled by hand. Large plants often use automatic vacuum or pneumatic loading systems attached to railroad cars; chemicals go into large storage bins and then into a dry feeder. This would usually be a gravimetric-type feed so that it could handle the large quantities of chemical required.

Cold Process Clarifiers. This process is used for the removal of turbidity from surface supplies and also to accomplish partial softening. It is an important part of many boiler feedwater treatment plants. Coagulants and softening agents (generally lime) are added in solution or slurry form to large volumes of water in solids-contact units.

An inlet meter which transmits to an indicating, integrating and recording receiver proportions the feed of chemicals to the raw water flow. It can also control automatic desludging. Water level in the clarifier is governed by an air-operated control valve which includes a limit stop to prevent excessive throughput. It is controlled by a displacement-type level controller.

Generally, a level controller on the clearwell regulates a diaphragm-operated valve on the clarifier inlet and governs flow.

Desludging valves can be operated by the inlet meter contactor or by a cycle timer. Using the meter-controlled system, the timer operates for a set period a predetermined number of contacts on the meter, opening and closing the desludging valves and high-pressure water system backflush valves.

Mechanical Processes

Deaerating Heaters. The most widely used mechanical unit in the treatment of boiler feedwater is the deaerating heater. Flow to deaerating

heaters which are incorporated in central-station cycles is controlled as follows: At low level in the deaerator storage section, a level switch opens a valve on the discharge line from the condensate tank. This allows water to flow from the condensate tank into the condenser hot well, thus bleeding water into the system.

When high level is reached in the deaerator storage tank, a level switch opens a valve on the discharge side of the condensate pump. This causes water to flow into the condensate tank, thus diverting flow from the heater. Overflow control on the deaerator is eliminated when this type of control system is used.

Panelboards

Panelboards and panel-mounted instrumentation ordinarily are basic requirements of the modern demineralization plant. However, they can also be used to advantage with other types of treatment systems. The cost of the treatment plant can be substantially affected by the type and design of the panelboards. Normally it is recommended that at least a local panel be supplied to mount basic instrumentation. While an expensive graphic panelboard may not always be justifiable, it is advisable to include at least a simple flow diagram on the panel front.

If the expense is warranted by the size and complexity of the installation, a graphic panel is certainly a useful adjunct to the automatic equipment. Figure 4 shows a typical graphic panel in which positions of all valves are indicated by lights on the flow diagram. This plant did not happen to have remote recording instruments. Ultimate panel design for a plant such as this would include miniature instruments showing not only valve positions, but also recording flow, conductivity and pH.

All instruments are placed on the panelboard flow diagram where their function dictates. This is the most costly type of panel that is furnished with a water treatment plant, but it is essentially the type of equipment which is being used today for complex water treatment systems associated with subcritical and supercritical boiler pressures.

Monitoring Systems

To check and indicate malfunction in the operation of automatic demineralizer plants, monitoring systems have been developed. A typical monitoring system provides an "electrical shadow" which follows the cycle control sequence, and the operation of the automatic valves and auxiliaries. If a valve operation or sequence is not functioning properly, the monitor receives impulses from a feedback, and indicates and locates the problem. The unit can be arranged to sound an alarm, shut down the plant, or both.

A typical monitor panel has three basic groups of lights. One group shows if the demineralization units are in service, regeneration, backwash or rinse. Another group indicates which step in the process is taking place.

Third group has a series of three lights for each valve, pump or other auxiliary. The first light is on when the specific valve or item is *supposed* to be open or running, the second is on when the item is actually open or running and the third is a red light that goes on when the item is not functioning in proper sequence and indicates the cause of the shutdown or alarm ringing.

With additional equipment the monitor can also be made to keep a permanent record of the demineralization operation and also to check on its own operation. A lamp test control can be mounted which shows at the push of a button if the panel's lights are in working order. Another control can indicate if there is a power failure. Other indicators and controls can be included in the panel according to the specific conditions and problems of each plant.

Decision as to the degree of instrumentation and types of panelboards to be used for a demineralizer plant must be made in the light of the unit's application and place in the plant. In a new utility or refinery installation, the extra expense for complete remote instrumentation is frequently justifiable on the basis of labor saving.

Designing the System

Design factors for controls and instruments are similar to those which apply to instrumentation of fuel, steam, air flow, boiler level, turbines, fans and processing equipment generally. Although proper design and selection of durable equipment is necessary for dependable operation, an important factor is the proper adjustment of all equipment on start-up.

Here are design factors which should be given careful consideration:

1. The control system should be based on available attention and labor time.
2. Pressure regulators should be incorporated into the design if constant air and water pressure is not already available.
3. Valve designs should be based on the specific air and water pressure characteristics of the system.
4. Key valves should be designed to close on air failure.
5. Pneumatic systems should include air receivers and reservoirs where needed.
6. Oil- and water-free air should be available for controls and instruments.
7. Dust-proof and vibration-free electrical equipment should be used throughout.
8. Careful attention should be paid to proper adjustment of reset counters, relays, switches and other contact-type equipment before plant is started up.
9. Valve operators should be rugged to assure consistently-dependable performance; they should have performance characteristics that fit into over-all control system.
10. All control equipment should be conveniently accessable.
11. Proper materials of construction should be used throughout the regeneration system.
12. Sample points for conductivity, pH and other probe meters should be designed to eliminate stagnant pockets and time lags between sampling and measuring.

Difference in initial equipment cost between a manual and a fully-instrumented plant of the types described above is small, running approximately 10 to 20 per cent for a complicated demineralizer. On an installed basis the difference would come to less than 5 to 10 per cent. On other types of equipment the difference is even less.

For most complex or large demineralizing systems today where ultrapurity and completely dependable operation are required, semi-automatic or fully automatic controls are almost always justified. THE END

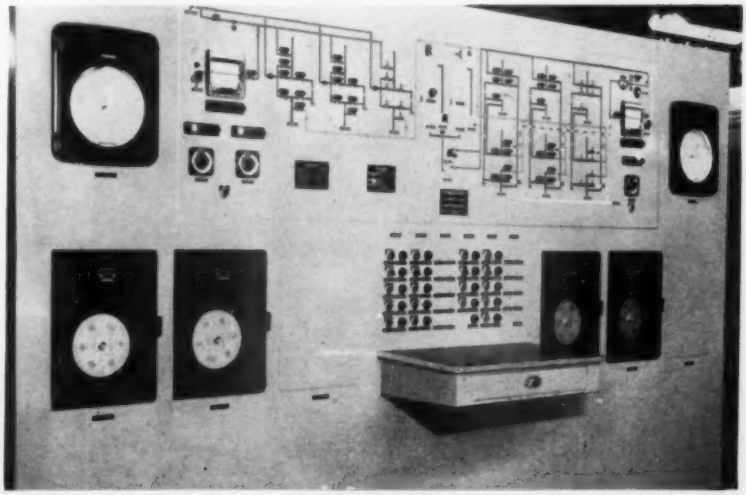
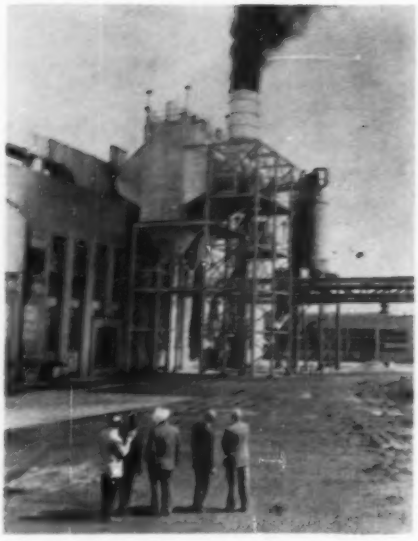


Fig. 4. Graphic panel for control and instrumentation of two-bed demineralizer

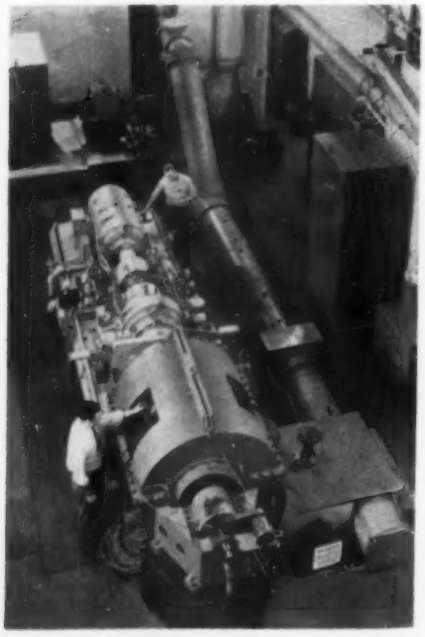
POWER ENGINEERING'S NEWS REEL

Power Test Code subcommittee of ASME, meeting in Schenectady to study revision of code, inspects dedication plaque on historic Curtis first large steam turbine generator. Host is A. I. Dahl of G-E. Left to right are: C. A. Macaluso, Worthington; C. A. Vogelsang, Minneapolis-Honeywell; R. D. Thompson, Taylor Instrument; J. W. Murdock, U. S. Naval boiler lab; R. C. Stroud, Leeds & Northrup; C. A. Black, Westinghouse

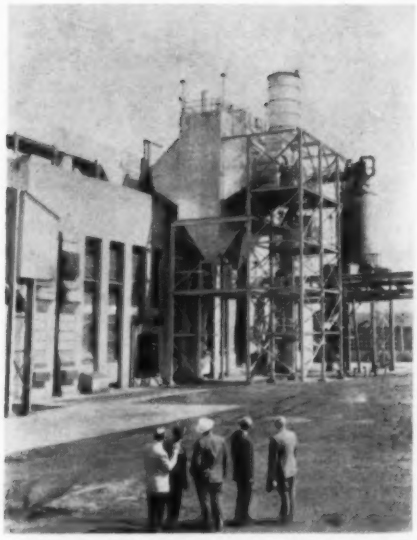
33,000 v indoors is a record substation installation recently completed in a concrete block vault located in basement of Collegeville, Pa., plant of Superior Tube Co. For safety, wires from primary line were sheathed in lead and brought underground to basement location. Inside location permits enlarging of plant without moving station to make room



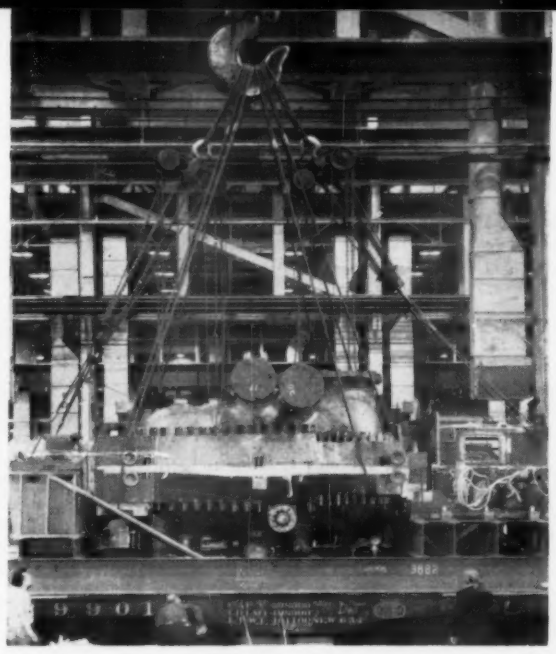
Smoke control gets vivid demonstration at Columbus, Ohio, plant of North American Aviation. In this view, electrostatic precipitator (box between stack and building) has been de-energized. Unit was then re-energized



Guinea pig turbine is this experimental unit built by Allis-Chalmers as part of a new test program to obtain more performance data on blade designs. Spindle, inner cylinder and flow guides near the blade path can be changed to suit various bladings. Air was selected as the turbine's working fluid



. . . **and 43 sec later,** the stack looked like this. Precipitator was built by Metal Products Division of Koppers Co. Watching demonstration are power engineers from plant and members of city smoke inspection staff



Chained power well describes this 180-ton high pressure turbine portion of a 200,000-kw cross-compound unit. Perfectly balanced by an intricate maze of cables and chains, it is lifted by a crane from assembly stand and swung onto a flatcar at G-E plant for shipment to an eastern utility

Coal unloading from this 8-ton stationary tower will expedite operation at Wisconsin P&L's new Nelson Dewey Generating Station on Mississippi near Cassville. Mead-Morrison made tower, with free-digging capacity of 845 tons per hr on 34-sec cycle, a-c control ▶

New home for electrical engineering at Missouri School of Mines and Metallurgy at Rolla, Mo., will be this 3-story building of reinforced concrete column and beam, panel wall construction. Completion is set for next summer

▼

The Computer: A Valuable Tool

By G. F. TREXLER*

THAT A GOOD PORTION of the conservative power industry has taken computers to its bosom indicates that these machines have an important place in the field. Yet enough misleading information has been written and spoken about digital computers to make them appear to some people as mystifying electronic geniuses about to replace our brainiest scientists.

Neither description is valid, of course. But what is a computer? How can it be used by the power industry?

First of all, a computer is nothing more than a tool for management or engineers. There is nothing a computer can do that an engineer with slide rule, paper and pencil can't do — provided he is given enough time. The only difference is that the computer can do it so much faster — almost infinitely faster in some cases. Also, the use of a computer in a utility, for instance, tremendously broadens the scope of its daily work. It provides flexibility to predict such things as load trends and consumption with an accuracy previously unknown in the industry.

An excellent example of the speed and accuracy of a small computer in a power industry application is the determination of radial fault calculations. In recent years, many of the utilities have been expanding their power networks with radial lines. In doing so they have also increased the voltage supply (say a changeover from 4 to 13.2 kv) in order to produce and distribute electrical power in a more efficient and economical manner.

Yet the same step-up in voltage has created the problem of increasing the number of outages three-to-four fold simply because there is three to four times as much exposure to lightning, trees, birds, squirrels, and small boys with .22 rifles.

In this case there are two ways a computer can help the utility. When trouble occurs, through a computer program, for instance, the engineer in charge can dispatch his maintenance people to the exact trouble spot. Compared with the hit-or-miss methods used without a computer this saves the company many hours of searching.

In addition to location of a particular trouble spot, the same computer program can solve the important engineering problem of location of various protective devices, such as reclosers and fuses. Under non-computer methods an engineer doing laborious calculations might take a number of short-cuts and arbitrarily choose points on the circuit where he "feels" reclosers will supply the optimum protection. This is fine when he's right; but if the location should prove inaccurate the resultant trouble nullifies any right guesses he might have made in other parts of the system. With the computer, however, there is no need for any short-cuts or guesses simply because the electronic machine does the calculations and does them at

* Manager, Public Service Industries, International Business Machines Corp

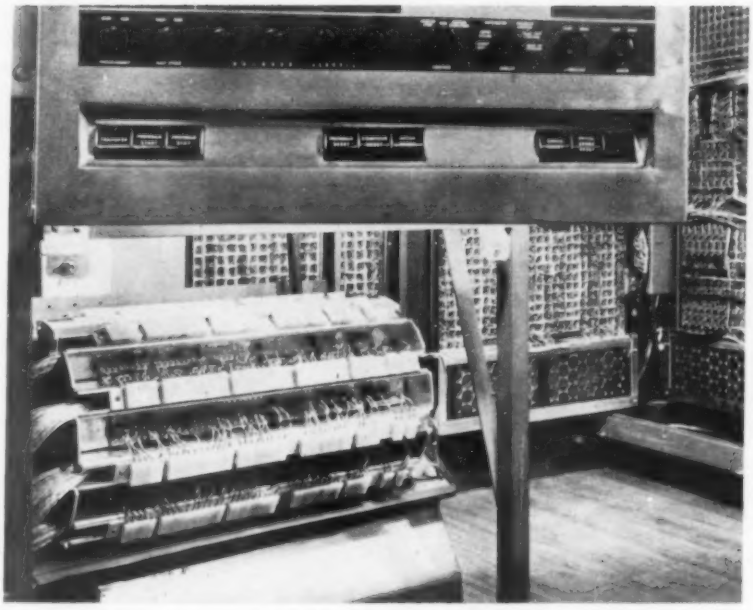


Fig. 1. Magnetic drum, capable of providing up to 20,000 memory positions, storing data and instructions. Part of works in background, part of controls above

Fig. 2. Load-flow studies are made at Bonneville Power Administration. Rodney J. Brown, above, helped devise method

Fig. 3. One of three computers operated by Gulf Oil in handling complex engineering and process problems of refineries

for the Power Engineer

such tremendous speeds that the engineer has his answers in a matter of minutes.

In short, what the computer does here is to give the engineer values computed for numerous locations in order that he may make a more accurate decision as to the economical placement of protective devices.

In actual practice evaluating an 11-mile circuit with 30 points, for example, an IBM 650 computer can complete calculations in about 45 seconds whereas an engineer doing the same computation by slide rule would take two to three days considering normal interruptions. The computer, therefore, is a tool for the engineer — just as his slide rule is a tool — which he can use to gain time for other important jobs.

Range of Problems

The answer to the question "How can computers be used by the power industry?" would take pages just to list the functions without explaining them in detail. Generally speaking, however, we can divide computer use into two or three broad categories: Customer billing and general accounting; daily operational problems; and scientific problems. In practice there is no clearly defined line between these categories because statistics gathered as a result of customer billing, for instance, can be used for solving daily operational problems; while the results of operational calculations can serve as input material for theoretical problems.

Talking about customer billing first — probably the main application of electro-mechanical and electronic equipment in the power industry today — we get into such factors as punched cards and mark-sense meter reading. With these methods of recording customer data, for instance, the power company knows each month just how much power each consumer has used; and if the customer has just bought a fan, air conditioner or washing machine the purchase will show up on the monthly bill as increased consumption. The company also knows the class of consumer they are dealing with and by combining these factors mathematically they can determine just how and when maximum demands for power occur and grow.

As an example of an actual operation, one midwestern power company bills approximately 475,000 electric-service accounts each month out of a single office. When you consider this volume, plus the factors of arrears, service changes, current billing and merchandise purchase, the job takes on the aspects of a major accounting problem.

Yet, utilizing an IBM 650-EDPM, this company is able to complete the entire billing operation for all its customers in just one computer run. The current meter-reading cards are fed into the computer in meter-reading sequence. The machine rapidly calculates the consumption to be billed, the billing period, net and gross billed amounts, and punches the results into these same cards.

Simultaneously, the computer accumulates route control, revenue and sales analysis statistics on its magnetic drum by district and rate classification, and by each rate, rate area, and ending block classification. The statistics are removed from the drum twice a day and punched into revenue control cards used for subsequent month-end reports.

In essence, the computer is handling all of the company's accounting work in a single machine operation — calculating and producing monthly bills, and accumulating statistics in such a manner they can be applied to every type of accounting report produced by the company. Under previous methods the same jobs required up to a dozen processing steps, and far more time to complete.

From a billing operation such as the one described, the power company easily moves into the area of planning and scheduling of daily operations and maintenance of facilities. Take the placement of distribution transformers, for example: Any street has several transformers, and they cost about $1000 each, including installation. One fairly-small utility can have 10,000 transformers of this type, or an investment of $10,000,000 in all.

As the demand on each transformer grows the company must take care that it doesn't pass a certain limit, otherwise it will just burn out and bang goes $1000, plus the bad customer relations resulting from missed TV programs, stopped electric clocks, and blacked-out houses.

Avoiding Outages

Under non-computer methods the chances of avoiding transformer outages fall in the long-shot category. The utilities try to inspect each transformer regularly to measure the loads on them. This means a truck and a crew of men; it means climbing poles carrying high-voltage lines in order to hang meters; going back 24 hours later to bring down the meters, read them and hope they hit a day which would show the high reading.

But even as they read the meters they know they missed the boat because the next day turns out to be humid and all the air-conditioners cut on, the ball game is re-scheduled for night, and there's a prom at the high school gym. So out goes that transformer, out goes the line crew again to bring it down and put up a new one at a good-sized cost plus overtime.

A company utilizing a computer for their billing operations, however, can avoid at least 90 per cent of these

Figs. 4 & 5. Versatility in arrangement is evident in basic units of IBM 650, requiring some 500 sf of space, 100-amp service, five tons of aircon. As refinements are added, needs rise to 1400 sf, 400 amp (120 volts), 15–20 tons of aircon

outages simply because they have in punched card form a valuable library of statistics which can be fed into the computer again to determine a number of factors. Feeding customer account cards into the machine, for example; it's a simple matter to find out the month of each consumer's maximum demand, and the probability of the number of maximum demands that will occur to form the peak.

If, at the same time, transformer cards are fed into the machine, then the output will be a listing of each transformer, its rating, its loading, and whether or not it should be changed on the basis of peak consumer demand.

In other words, by feeding into the computer some of the statistics gathered for the billing operation, a utility company can judge more efficiently distribution of its principle product — electricity.

Load Predictions

But computation of current load trends is just one small facet of a computer's use in a power company. Moving into the realm of future predictions, for example, the same machine can forecast peaks for coming years. To do this, one card is read into it for each past year, and in each card is punched the year and the highest kilowatt peak for that year expressed in terms of megawatts.

As the computer reads each card it accumulates the summation of years and the summation of the peaks in logarithm form. Rapidly going through a series of equations, based on program cards previously fed into the computer, the machine computes the anti-log of the per cent of increase found above, and arrives at the increase in percentage form.

Thus, having computed the per cent of increase over a series of years, the computer then forecasts what the high annual peak should be during the next one, two, or 20 years.

Advantage of computer use for computation of statistical load trends is that more accurate data can be obtained in a shorter period of time. Current-year calculations handled on a manual basis by an engineer, for example, require about eight hours, with no forecasting done. On an IBM 650, however, this data can be computed in about two minutes, with a high degree of forecasting thrown in.

A salient feature of all jobs performed on computers is the fact that in most cases they can be performed when they are needed, and not at some future date when the time and personnel are available. Programming of a typical computer is carried out by means of punched-card or magnetic-tape instructions which are retained in the machine's memory. Then when the actual problem equations are fed into the machine it requires only fractions of a second to move from one stage of processing to the next, and it is this tremendous speed which allows the power companies to perform a variety of jobs with computers.

It becomes increasingly obvious that the range of applications of a computer in the power industry approaches the unlimited point. But it is necessary to get computer usage into its proper perspective. To do this let's consider as an example the question of determining an economical conductor size.

Conductor Sizing

Where it is possible to predict exactly the load factor, conductor costs, annual line charges, cost of generation, annual peak, amperes, and estimated load growth, then with the aid of Kelvins Law and perhaps an empirical relationship between copper loss factor and load factor, it is possible to develop formulae which will permit an intelligent guess at the most economical conductor size.

All of the above can be done with one solution of the formulae and for this there is no need to use a digital computer. But perhaps the power company is not certain whether they should use copper or another substance, the cost of which may vary quite a few cents per pound. Again load factor may vary over some 20 per cent and generation costs several mils. Also it may be necessary to include several values of annual peak amps over a 5-, 10- or 15- year period of load growth.

In short, from a practical standpoint, in order to determine an economical conductor size the utility must take into consideration numerous variable factors broken down into formulae which must be processed over and over again before a satisfactory answer is reached. This is the point where the digital computer provides invaluable aid for the company.

Rather than have an engineer sit for several days with a desk calculator trying out all the combinations of these or other problems, it's far faster to let the computer do it for him in a matter of minutes. Once the program (the sequence of necessary instructions to the machine) is written it can be used over and over again for any number of variables the engineer may wish to try.

Answers will be produced much more accurately and in much less time, without his being present. The IBM 650, for example, could perform a calculation of this type in a matter of seconds. Then, having calculated, for instance, 397-mcm stranded copper as the most economical conductor size, the computer can look up a table of available conductor sizes and pick out 400 mcm as the nearest readily-available size. It is within the scope of this and other sizes of computers to make logical decisions and look up tables.

Once again it is evident that the computer in a power industry is a highly potent tool for carrying on the daily work of the company. Starting with the generating stations, for example, there is the daily problem of properly scheduling units in accordance with equal incremental-loading principles taking into account system losses. (See Planned Incremental Loading Gives Efficient Power System Operation, page 72.)

Associated with this there arises the matter of constantly producing up-to-date load-duration curves on a monthly, yearly and cumulative basis. All this work is tedious and much more appropriate to high-speed analysis by data-processing machines than by intelligent and highly-trained individuals.

In the case of hydro power, the economical use of hydro storage, performing of water regulation studies and forecasting of river flow have to be considered. Another application done in this field is the determining of the relative severity of thermal stresses developed at the base of a dam for various sizes of base length. All of this work, basically mathematical calculations, can be done very much faster and in more complete form by data-processing equipment.

Going out into the systems themselves, computers can prove invaluable in solving problems involving load-flow and loss studies, short-circuit calculations, transient-stability studies, sag and tension calculations, conductor spacing and tower design, insulation coördination and, in underground systems, thermal radiation from cables, to mention only a few cases.

What has been said about the generation and transmission stations can be matched at the substation, primary and secondary-distribution level as well. In fact, once the decision has been made to use a computer as an aid in a power company there is no problem of operations that cannot produce some benefits through electronic calculation. The logical abilities and tremendous operating speeds of digital computers permit them to make many of the repetitive decisions which today consume so much engineering time.

In essence, then, a computer in a power industry application is nothing more or less than a tool to help management and engineers do the necessary jobs to keep the company running at peak efficiency. THE END

Want Extra Pages of Articles?

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Fig. 1. Artist's rendition of Delaware Power's new Indian River Power Plant. Note natural discharge canal in the distance. Lower cost per kw resulted

To an ascending load curve add a large dash of imaginative management and a site to which nature has added her own engineering touch. The result is . . .

Ideal Site Reduces Plant Cost

By EARLE M. SOMMERFIELD * and ROBERT M. MULLEN †

QUESTION OF NEW CAPACITY was answered by the Southern Division of Delaware Power and Light by the construction of their new Indian River Power Plant, Fig. 1, on the banks of the Indian River near Millsboro, Del. The site was selected after thorough study of the Delmarva Peninsula to find a property large enough for the plant within reasonable distance of the railroad and a main transmission line and with sufficient cooling water. It has the added advantage of being high ground close to deep water, a nine and one-half ft channel in Indian River passing the plant site.

Cost Analysis

Design and construction cost for the first unit was approximately $16,325,000 and the estimate for the second unit is $11,985,000. Based on a capability of 90 mw each for the two units, the cost per kilowatt is $157. Switchyard costs of $1,690,000 for the two units, cost of land and interest during construction are not included in the above figure.

An Assist from Nature

Nature has provided Island Creek for easy discharge of circulating water through a four mile circuit to minimize the effect of recirculation, since it is about two miles to the East that Island Creek joins the river.

Use of corrugated asbestos siding rather than masonry saved Delaware Power and Light approximately $200,000 in building costs.

Station economy also entered the picture. This plant is ventilated by taking air in at the top of the boiler room. The air picks up the heat of boiler radiation and eventually ends up in the forced draft fan inlets which are located indoors.

All major control over the two units is from the central control room with the exception of burner ignition. These controls are located at the burners. One operator with an assistant mans the control room. An auxiliary operator performs the required roving.

All operations are controlled from benchboard type panels, with steam and electrical controls for boiler and turbine located adjacent to each other for maximum convenience.

As much of the operating floor as possible is made visible from the control room by having full-width windows on each side. The air conditioned control room is slightly pressurized with ventilating air taken from outside the building. The room is provided with a luminous ceiling with acoustical treatment.

Advanced Boiler Design

Boilers are radiant reheat, pulverized coal fired steam generators

* Supervising Engineer, United Engineers and Constructors, Inc
† Superintendent of Production Delaware Power & Light Co

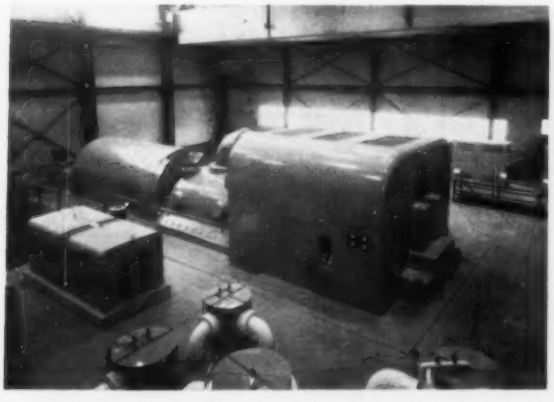


Fig. 2. View of operating floor showing turbine generator

Fig. 3. Indian River control room designed for units 1 and 2

Major Plant Equipment

Steam Generating Equipment and Pulverizers	Babcock & Wilcox	Traveling Screens	Link Belt
Air Preheaters	Air Preheater Corp	Coal Scales	Stock Equipment Co
Concrete Stacks	Custodis Construction Co	Coal Handling Equipment	Link Belt
Fans	Sturtevant	Ash Handling Equipment	Allen-Sherman-Hoff
Combustion Control	Bailey Meter	Traveling Crane	Whiting
Fly Ash Precipitator	Research-Cottrell	Car Shake-out	Stephens-Adamson
Boiler Feed Pumps	DeLaval	Air Compressors	Gardner-Denver
Fluid Drives	American Blower	Miscellaneous Water Pumps	Worthington
Deaerator	Permutit	Fuel Oil Pumps	DeLaval
Closed Heaters	Westinghouse	Water Treating Equipment	Graver
Turbine Generator Units	Westinghouse	Electrical Equipment	Westinghouse
Condenser	Westinghouse	Motors	Westinghouse
Circulating Water Pumps	Westinghouse	Diesel Locomotive	General Electric

which incorporate a number of advanced design features. Each is rated at 625,000 lb per hour at 1850 psi, 1005 F with reheat to 1005 F. At full load the efficiency is 90 per cent with temperature of the gas leaving the air heater at 240 F.

The superheater and reheater tubes are arranged vertically in a single gas pass with no turns, baffles or control dampers. Thus these high temperature surfaces are less susceptible to slagging, are easier to clean and require less soot blowing.

Primarily to maintain reheat and superheat temperatures at reduced loads, provision is made for flue gas recirculation from beyond the induced draft fan. No separate recirculating fan is used. Flue gas recirculation causes gas temperatures leaving the air heaters to rise slightly rather than fall as load decreases. Thus, added protection against sub-dew point condensation and air heater corrosion is obtained.

Turbines are guaranteed to produce 75,000 kw each with all heaters in operation and an exhaust pressure of 3.5 in. Hg. They are tandem compound double flow units, 3600 rpm with throttle conditions of 1800 psi at 1000 F and reheat to 1000 F.

Arranging Piping for Safety

The prime mover was designed to reduce hazard of oil fires as much as possible. This was accomplished by bringing all oil piping out to one side, all bleed steam piping to the opposite side and the main steam, cold and hot reheat steam lines in at the end of the unit at the front pedestal.

In addition to the usual throttle trips by overspeed, low oil pressure and low vacuum, the throttle is also tripped by thrust bearing failure, loss of generator field and operation of the differential and generator ground relays. An emergency throttle trip button is located in the control room and another at a remote location for use in the event of fire hazard.

Tripping of throttle also trips out all fuel supply to the boiler and closes attemperater spray valves. A throttle pressure regulator automatically decreases load on the unit if the throttle pressure falls to a predetermined value. Load is not restored automatically; is done manually.

Condensers are 50,000 sq ft single pass with divided water box.

Boiler Feed Pumps

Two boiler feed pumps are provided with each unit, each capable of supplying approximately two-thirds of the feedwater requirements of the boiler at full load. Pumps are barrel type, driven by 1500 hp motors through hydraulic couplings. These latter proved economically feasible since this was not planned to be a base load plant. Load factor expected is approximately 75 per cent with low night and week end loads. THE END

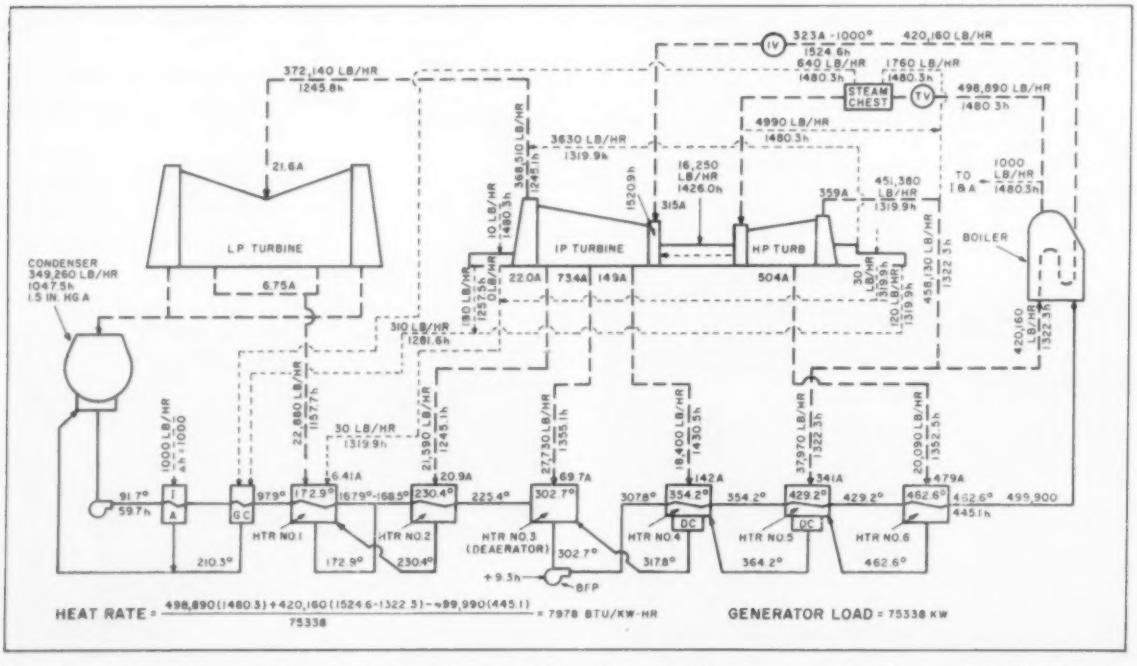


Fig. 4. Heat balance diagram for units 1 & 2 at Indian River. Quantities and values shown are for a unit loading of 75,383 kw

CONSTRUCTION NEWS

Birmingham, Ala. — Alabama Power Co, Alabama Power Co Bldg, 600 N 18th St, has announced contract award to the Morrison-Knudsen Co, Inc, Boise, Idaho, and Moss-Thornton, Leeds, Ala., covering preliminary construction work on Weiss Dam on Coosa River. Work will include diversion dam, power house superstructures, dikes, canals, spillways and roads. Contract award for this work reported to be about $9,500,000. Weiss dam is one of 4 projected dams to cost a total of $121,000,000 on the Coosa River in Alabama and Georgia. Dams when completed in early 1961 will have an initial capacity of 360,800 kw.

Tempe, Ariz. — Arizona Public Service Co, 501 S Third St, Phoenix, Ariz., has work under way on construction of new power plant on large site near here. New plant, to be known as the Ocotillo Power Plant, will be equipped with a steam-electric generating plant with an initial capacity of 230,000 kw. Plant will be completed by spring of 1960 at a reported cost in excess of $29,000,000. Ebasco Services, Inc, New York City, in charge of construction.

Millsboro, Del. — Delaware Power & Light Co, 600 Market St, Wilmington, Del., has announced plans for the expansion of company's Indian River Power Station here. Plans have been approved for new addition to steam-electric generating plant, with installation of new turbine-generator unit with an initial capacity of 85,000 kw. Preliminary work is already under way and added unit is expected to be placed on line late in 1960.Co st of installation reported to be about $25,000,000.

Decatur, Ill. — Illinois Power Co, 134 E Main St, has announced plans for major expansion and improvement of company's power plants, power substations and transmission lines over a five-year period through the 1962 season to cost an estimated $205,000,000. Five-year program includes a budget of $168,400,000 for new electric generating and transmission facilities to cover an expanded market, and $36,600,000 for expansion of company's gas properties including additional pipe-lines. Work on the new expansion is already under way.

Rockford, Ill. — Central Illinois Electric & Gas Co, 303 Main St, has authorized expansion of steam-electric generating station here. Work will include design and construction of a new 50,000-kw steam-electric generating unit to be designated as unit No. 4 of company's Sabrooke Station. Cost of new installation reported to be in excess of $11,000,000. Stone & Webster Engineering Co, Inc, New York City, are construction engineers of the new addition, which is scheduled to go on line in 1961.

Plainfield, Ind. — Public Service Co of Indiana, Inc, has plans under consideration for the construction of a large new power generating station at the Indiana end of the Markland Navigation Dam, now under construction by the Army Corps of Engineers on the Ohio River. Company has requested permission from the FPC to build the station which will have an annual electrical output of 448,000 kw. New facility when completed will represent an investment in excess of $25,000,000.

Ford, Ky. — East Kentucky Rural Electric Coöperative Corp Lexington Rd, Winchester, Ky., has approved plans for addition to steam generating plant here. Work will include installation of additional equipment for increased capacity, including steam turbine, high-pressure boiler, coal pulverizer, etc. Central Contracting Corp, Oshkosh, Wis., will begin construction soon at a reported cost approximating $375,000. Addition is scheduled for completion by late 1959.

Lexington, Ky. — Commonwealth of Kentucky, Division of Purchases, Frankfort, Ky., has awarded contract involving expenditure of more than $2,100,000, to Hargett Construction Co, Lexington, Ky., for construction work on power plant tunnel and auxiliary facilities, for the University of Kentucky Medical Center, located here. Work is already under way for completion by early 1960.

Alexandria, La. — Louisiana Rural Electric Corp, P. O. Box 111, has announced that work is under way on a major expansion and improvement program of company's rural distribution lines and related facilities. Company is now in the process of expending about $2,600,000, on 206 miles of distribution lines, 190 miles of 34.5-kv transmission lines, 19 miles of additional tie lines, 15 miles of conversion lines to increase voltage, and construction and improvements to 11 substations.

Asbury Park, N. J. — Jersey Central Power & Light Co, 501 Grand Ave, has plans under advisement for the outright purchase of the assets of the Tri-County Rural Electric Co, of Freehold, N. J. Stockholders of the latter company, by a vote of 10 to 1, have authorized the company's board of directors to negotiate with Jersey Central Power & Light Co, for the sale. Tri-County, which buys its power from Jersey Central, was formed in 1937 under the REA program to extend electricity to farm areas which private companies found too costly to service. Inspection of the coöperative's physical assets is expected to bring a firm offer of purchase from Jersey Central Power & Light Co.

Hurley, New Mexico — Kennecott Copper Corp, Chino Mines Div, 161 E 42nd St, New York, N. Y., has approved plans for major addition to company's electric power plant here, with installation of additional generating equipment for increased capacity. F. J. White Engineering Co, Englewood, Colo., has been authorized by the company to design and construct power plant addition with an initial capacity of 16,500 kw. Work on the new addition, reported to cost about $3,000,000, will begin at once for scheduled completion early in 1961.

Fort Worth, Tex. — Harris Hospital, 1300 W Cannon St, has plans under consideration for the construction of an auxiliary building and power plant on Puritt St, just opposite existing hospital building. Hospital, care of W. P. Earngey, Jr., will accept bids for the construction of the new facility in the near future. Cost of the proposed unit reported to be in the neighborhood of $750,000.

Ogden, Utah — Marquardt Aircraft Co, 7735 Kester Ave, Van Nuys, Calif., has authorized plans for the construction of a test cell building, including large boiler plant and auxiliary equipment, water treatment plant and related work at Aircraft-Marquardt Jet Laboratory here. Cost reported to be about $2,517,000. Work will begin at early date for completion by early 1960. Rosendahl Corp, Los Angeles, Calif., has been awarded the construction contract.

Quantico, Va. — Virginia Electric & Power Co, Seventh & Franklin Sts, Richmond, Va., has awarded a contract to the Combustion Engineering Co, Inc, covering the installation of a 200,000-kw controlled circulation boiler to be installed at company's Possum Point Power Station located here. Work to be done will represent a $5,000,000 expenditure. When current installation is completed in 1960, company's system-wide capacity will be 1,600,000 kw as compared to present capacity of 1,150,000 kw.

Richland, Wash. — Atomic Energy Commission, 1901 Constitution Ave, NW, Washington, D. C., has approved plans for the construction of a plutonium recycle test reactor and fabrication pilot plant on large building site here. Work will begin at once on the $1,897,874 project, which is scheduled for completion by early 1960. Hoffman Construction Co, Portland, Ore., construction engineers, are doing the work.

Power Engineering handbook

How To Maintain Centrifugal Pumps

By J. A. CABLE and O. M. KRISTY, Jr.*

WHAT BETTER PLACE is there to start than with that lowly, necessary evil — the stuffing box?

Definition: a stuffing box is a cylindrical cavity surrounding the point of shaft entry, which is fitted with a means of throttling leakage through it.

This article will concern itself with stuffing boxes fitted with packing. In a later article, we will cover pumps equipped with mechanical seals.

Easiest stuffing box to maintain is one properly chosen in the first place. The table at the end of this article (page 100) outlines how stuffing boxes should be equipped for various pumping applications and then tells how these arrangements should be maintained.

The following comments apply to many of the various types of stuffing box arrangements described in the table.

External Seal Liquid Pressure

When stuffing box pressure is less than atmospheric, 10–15 psig should be used for sealing.

When stuffing box pressure is more than atmospheric, 15–20 psig over suction pressure should be used with double suction pumps and single suction pumps having balance holes through the impeller. With special single suction types designed for slurry pumping, seal water will usually be needed that is 15–20 psig over one-half of the maximum discharge head.

*Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

Seal Liquid Valve Setting

Valve should be opened just enough to produce pressures in the order of these outlined above. In all cases the criterion is that the setting must allow a normal leakage from the packing, that is, a steady slight dripping. A dripping of 30 drops a minute will leak about one gal in 24 hr. The higher the stuffing box pressure, the greater the sensitivity of this valve setting. Too much sealing pressure means that the packing will have to be tightened excessively to contain the pressure. This shortens packing and sleeve life.

Referring to Fig. 1, it should be kept in mind that the seal liquid is introduced for the purpose of sealing or flushing and lubricating the packing. The right pressure provides the sealing or flushing needed, but the leakage must be permitted in order to lubricate the packing.

Repacking

Step 1. Remove all old packing, including that below the seal cage, noting proper seal cage position.

Step 2. Thoroughly clean bore of box and surface of shaft sleeve. Replace sleeve if grooved.

Step 3. Carefully cut full rings of packing so that ends butt, leaving no gap.

Step 4. Tamp packing fully into bottom of box. Stagger each ring joint at least 90 deg with respect to one another. *Caution:* locate seal cage to match up with seal inlet passage or the sealing fluid

fold along this line—outside edges toward you

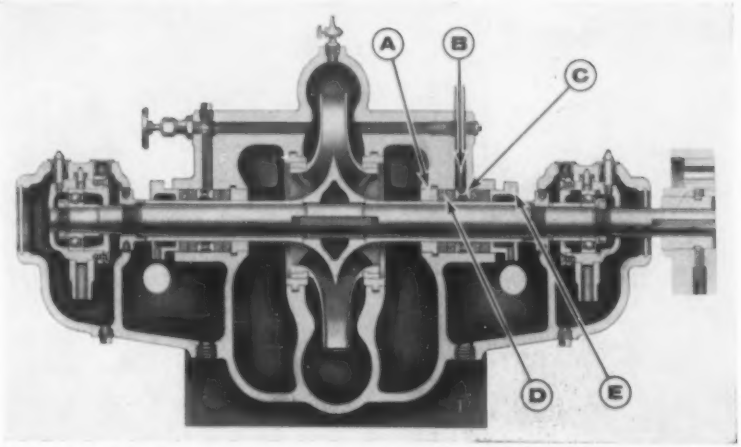


Fig. 1. Typical stuffing box with centrally located seal cage. A is casing bushing; B, for internal seal, water comes from within casing, from separate source if seal is external; C is seal cage; D is packing; E is gland

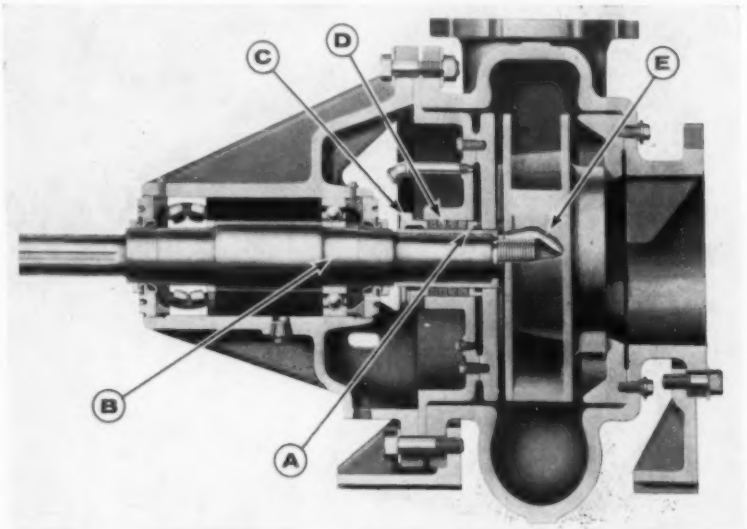
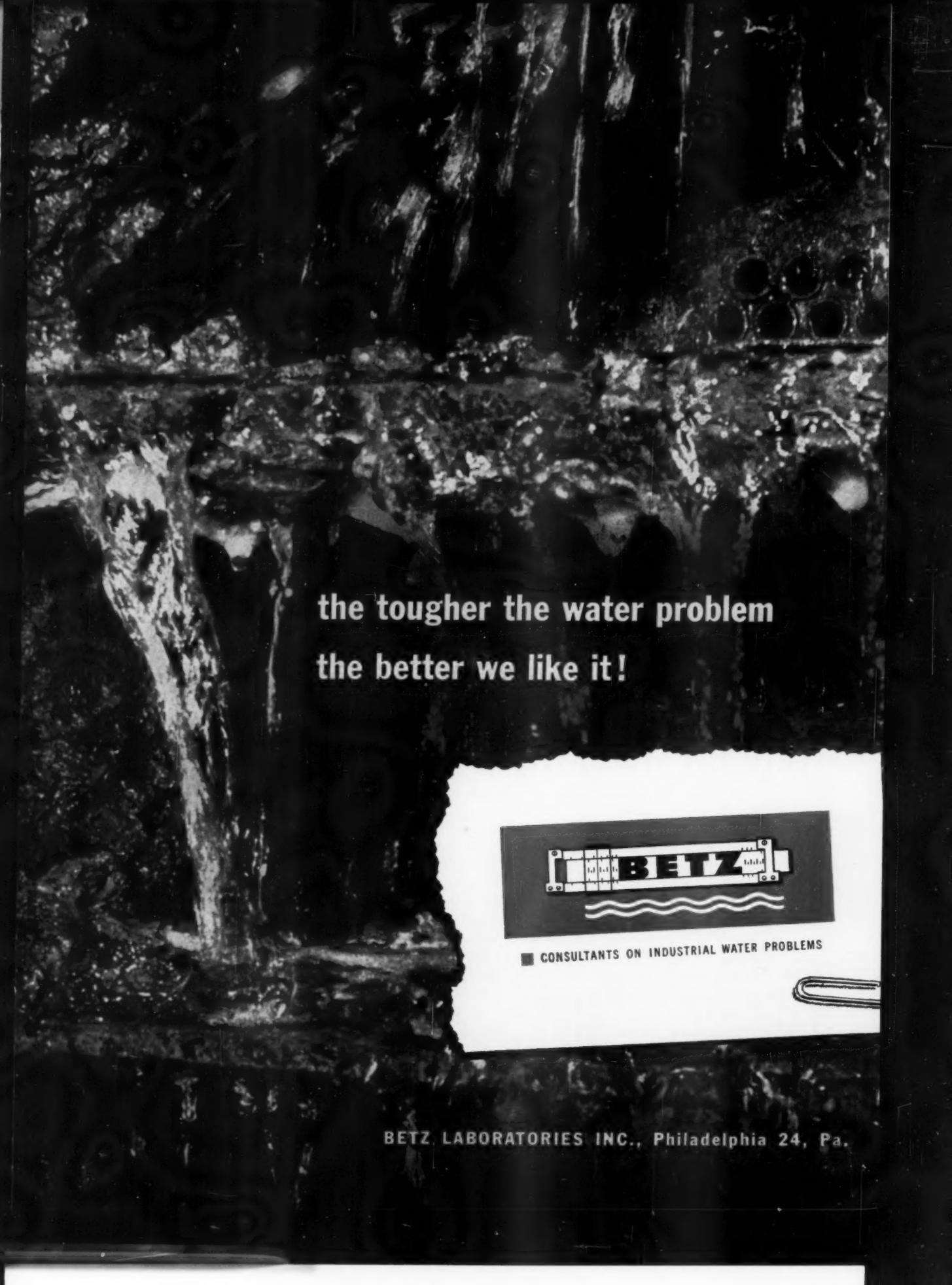


Fig. 2. Stuffing box typical for slurry pumps. A is special seal cage for positive flushing action; B is driven end; C is gland; D is packing; E is the impeller end. Packing for box is soft graphited asbestos

cut along this line


the tougher the water problem
the better we like it!
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

cannot enter. This point is important.

Step 5. Install gland square with stuffing box and pull up tight, with no internal pump pressure, to compress all rings of packing properly. Then loosen gland to allow packing to expand, reset gland bolt nuts finger tight, prime pump, and return to operation. Recheck sealing water lines and watch for normal leakage. If packing overheats or leakage is excessive, shut pump down and drain to remove pressure. Pull up gland to set packing, loosen and try again.

This process may have to be repeated several times to get packing run in. If unable to shut pump down again, loosen packing enough to prevent overheating. Then to regain proper stuffing box compression, tighten each gland nut one flat no oftener than every 20 minutes until leakage subsides. This will permit pressure to distribute itself equally over all rings of packing.

However, it is always best to make adjustments when the pump is not running.

This table outlines the preferred stuffing box arrangements for various conditions, and maintenance

Pressure packed against	30-ft lift (28-in. vacuum) to 15-ft lift	14-ft lift to 10 psi positive pressure	11 psi positive to 25 psi (if stuffing boxes extra deep, six rings of packing or more, this top limit can be 50 psi)	26 psi to 75 psi	76 psi to 150 psi
Preferred construction with clear lubricating liquids. If temperatures exceed 212 F, suggest use of 11/13% chrome sleeves and metallic packing. Also add a snuffing-type gland to condense leakage and prevent it becoming a hazard to personnel.	Soft graphited asbestos packing on hard bronze shaft sleeve. External sealed with seal cage.	Same as for 30-ft lift, but use internal seal.	Soft graphited asbestos packing and hard bronze sleeve. Eliminate seal cage and do not use external or internal seal.	Metallic packing and hardened 11/13% chrome shaft sleeves. No seal cage or seal liquid used.	Recommend mechanical seals. If packing is insisted upon, use 11/13% chrome hardened sleeves with special alternate rings of plastic and metallic packing. Also special close clearance gland and casing bushing. Omit seal cage. No seal liquid used.
Preferred construction liquids with intermittent solid content (i.e. dirty water).*	Soft graphited asbestos packing on hard bronze shaft sleeve. External sealed with seal cage.	Soft graphited asbestos packing on hard bronze sleeve (11/13% chrome-hardened preferred with any positive pressure). External sealed with seal cage.	Soft graphited asbestos packing on 11/13% chrome hardened sleeve. External with seal cage.	Metallic packing and hardened 11/13% chrome shaft sleeves. External sealed with seal cage.	Recommend mechanical seals. If packing is insisted upon, use 11/13% chrome hard sleeves with special alternate rings of plastic and metallic packing. Also special close clearance gland and casing bushing. External sealing with seal cage.
Non-lubricants	Mechanical seals preferred. If packed, external seal would have to be a compatible grease seal.	Mechanical seal preferred. If packed, seal would have to be a compatible grease seal.	Mechanical seals preferred. If packed, external seal would have to be a compatible grease seal.	Mechanical seals	Mechanical seals
Things to watch at start-up	External seal pressure on before start-up. Gland bolts finger tight allowing slight leakage of seal water.	Gland bolts finger tight desirable but may have to tighten more until pump is primed. After running, adjust for slight continuous leakage. Seal liquid valve well open when starting. After pump running, adjust to minimum opening that produces normal slight leakages.	Gland bolts finger tight allowing slight leakage of pumped liquid.	Gland bolts finger tight allowing slight leakage of pumped liquid.	Mechanical seals will be covered later in a POWER ENGINEERING Handbook feature. If packing, gland bolts should be finger tight allowing slight leakage of pumped liquid.
Maintenance	Keep seal water lines open. Take up on gland bolts to compensate for wear and compression of packing but do *not* prevent normal leakage.	Keep seal water lines open. Take up on gland bolts to compensate for wear and compression of packing but do *not* prevent normal leakage.	Take up on gland bolts to compensate for wear and compression of packing but do *not* prevent normal leakage. Because of high pressure, more frequent take-up will be needed.	Take up on gland bolts to compensate for wear and compression of packing but do *not* prevent normal leakage. Because of high pressure, more frequent take-up will be needed.	Mechanical seals will be covered later. If packing, because of high pressure, more frequent take-up will be needed.

For continuation of table see corresponding columns on opposite page.

*For slurry pumps, use special single-suction pumps having soft graphited asbestos packing on 11/13% chrome or other hardened material sleeve. External seal with seal cage preferably located at the inboard end of the stuffing box. This assures that seal fluids will prevent solids from entering stuffing box and getting imbedded in packing which would result in rapid wear of the sleeve (see Fig. 2).

POWER ENGINEERING HANDBOOK

fold along this line—outside edges toward you

cut along this line

Simplicity in steam traps can effect big savings in parts inventory and maintenance time

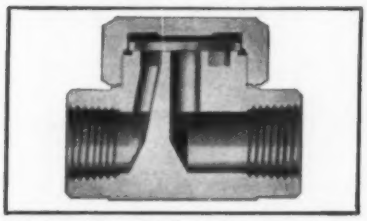
by John W. Ritter, Test Engineer
SARCO Company, Inc.

The function of all steam traps is to release condensate and prevent steam loss. However, the method of trapping can make a great difference in cost and effectiveness.

In the Sarco Thermo-Dynamic Steam Trap, the method is fundamental. Air or condensate entering the trap must flow from the inlet tube, radially across the underside of the disc valve, to the outlet. The space between the inlet tube and the disc forms a nozzle in which the static pressure energy of the incoming fluid is partly changed to velocity across the underside of the disc, with a resultant *decrease* in pressure. (This will be recognized, of course, as the Bernoulli Principle.) Use of this fundamental method means reliability in operation.

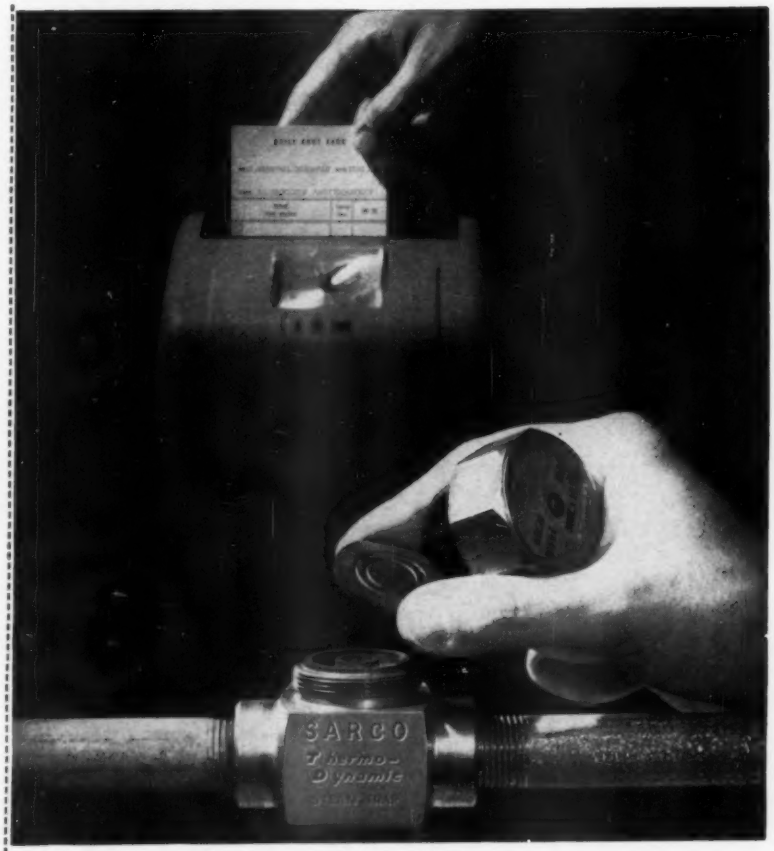
As the high velocity fluid jet strikes the side of the upper chamber, some recompression takes place, so that the pressure above the disc becomes greater than the pressure below it. The pressure reduction under the disc and the pressure recovery above it depend on the internal energy of the fluid. As the condensate above nearly approaches steam temperature, its internal energy is enough to overcome the upward force at the inlet tube and the disc snaps down in the inlet tube, which is the inlet valve seat.

Simultaneously, the disc also seals the outer ring, which isolates the space above the disc from the outlet. The disc valve is therefore held firmly against the inlet valve seat until the pressure in the control chamber is reduced by condensation. The upward force then exceeds the downward force and the disc valve opens.



This 3-part Sarco TD Steam Trap has only one moving part—the hardened, polished stainless steel disc.

No other trap uses the velocity of the fluid to operate the valve or uses the recompression of the flowing fluid to trap the valve closed and to hold it closed. When it closes, it closes tightly – no "operating steam" leaks out.



40 seconds inspection time— that's all it takes for a SARCO TD Steam Trap

Just back off the cap of a Sarco TD. Lift out its single moving part, the stainless steel disc. Wipe it off, and drop it back. No adjustment is ever required, at any load or any pressure in its range – from 10 through 600 psi.

The TD operates in any position, won't blow steam at any load. Small as a tee fitting, it can be installed in tight places. Its versatility and reliability cut cost of big replacement inventory.

Write for "Literature Kit 2A" today and get latest bulletins on the TD Steam Trap and other Sarco steam traps. Remember that Sarco can give you impartial advice on *Production Planned steam trapping* because . . .

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Thermo-Dynamic • Bucket

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Introduction to Steam Power

6—Properties of Steam

Sixth article in this serialized course on power plant fundamentals, developed by Commonwealth Edison Co for after-hours educational use. There will be two more installments—on Feedwater Analysis and Feedwater Treatment

STATES of water at atmospheric pressure:

1. Solid — (Ice). a. Exists at or below 32 F (atmospheric pressure). b. Density is considerably lighter than water. Ice at 32 F has a density of about 56 lb per cu ft. c. Specific heat is approximately 0.5 Btu per lb per deg F.
2. Liquid (Water). a. Exists between 32 F and 212 F (at atmospheric pressure.) b. Density varies from 62.4 lb per cu ft to 59.8 lb per cu ft with a maximum density of 62.42 lb per cu ft at about 39 F. c. Specific heat is approximately one Btu per lb per deg.
3. Vapor (Steam). a. Exists at temperatures above 212 F (at atmospheric pressure). b. Density is 0.037 lb per cu ft at 212 F and decreases as temperature is increased. c. Specific heat is approximately 0.5 Btu per lb per deg F.

Changing Water into Steam

1. Evaporation
   a. Vaporization which occurs only at the free surface of a liquid.
   b. Occurs at all temperatures below boiling point if space above is not saturated.
   c. Increases with the extent of surface exposed.
   d. Depends upon the nature of substance.
2. Ebullition (Boiling)
   Vaporization which takes place within the body of a liquid.
3. Vaporization Temperature
   Temperature at which boiling occurs is controlled by the absolute pressure exerted upon the water.

Conditions of Steam

1. Saturated Liquid (h_f)
   a. Water at the temperature corresponding to the boiling point of the liquid at a given pressure.
   b. When heat is added to a body of saturated steam in contact with water at a given pressure, more of the water vaporizes, but the temperature of the liquid and vapor remains constant.
   c. It will remain saturated as long as it is of the same pressure and temperature as the water with which it can remain in contact.
2. Wet Steam
   a. Saturated steam that contains water particles.
   b. The percentage by weight of steam in a mixture of water and steam is called its quality. Example: Steam containing 10 per cent moisture is said to have a quality of 90 per cent.
   c. The quality of wet steam may be determined by use of a throttling calorimeter.
3. Dry Saturated Vapor (h_g)
   a. Saturated steam that contains sufficient heat energy to maintain all of the substance in vaporous form.
   b. There is a definite temperature for every pressure at which steam remains at the dry saturated point.
4. Superheated Steam
   a. Steam, the temperature of which is greater than that of boiling point corresponding to the pressure on it. Superheat is attained by applying heat to the steam after being separated from contact with the liquid.
   b. Superheat steam will permit a variation in temperature, above saturation temperature without condensation.

Heat Quantities

1. Heat of the Liquid
   a. The heat necessary to raise the temperature of 1 lb of liquid from 32 F to the boiling point at any given pressure.
   b. At moderate pressures and temperatures, heat of the liquid may be approximated by subtracting 32 from the temperature of the liquid.
2. Latent Heat of Vaporization
   a. The heat required to change 1 lb of a liquid at a given temperature into a vapor at the same temperature.
   b. The latent heat of vaporization of water at atmospheric pressure is 970.3 Btu per lb.
3. Superheat
   The heat required to raise the temperature of 1 lb of dry steam from its saturation or vaporization temperature to existing temperature.
4. Total Heat of Steam (Enthalpy)
   a. Dry saturated steam
      $H = h_f + h_{f_g}$
   b. Wet steam
      $H = h_f + x h_{f_g}$
   c. Superheated steam
      $H = h_f + h_{f_g} + c_p (t_{sh} - t_s)$
      H = total heat (Btu per lb)
      h_f = heat of the liquid (Btu per lb)
      h_{f_g} = latent heat of vaporization (Btu per lb)
      x = steam quality (per cent)
      c_p = mean specific heat of superheated steam at given temperature and pressure
      t_{sh} = temperature of superheated steam (deg F)
      t_s = saturation temperature at given pressure (deg F)

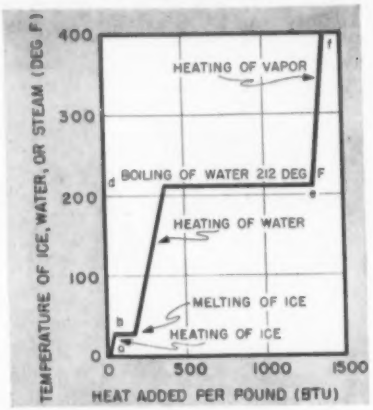

Fig. 1. Changes of form of water at atmospheric pressure. Density at 212 F is 0.037 lb per cu ft

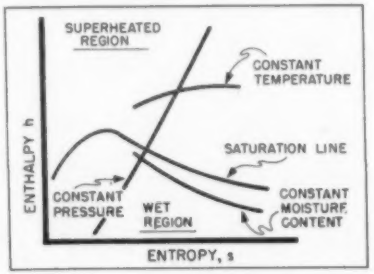

Fig. 2. Sketch of Mollier diagram. Abscissa represents total entropy; ordinate, the total heat

Use of Steam Tables and Charts

1. Reason for Tabular and Graphic Methods
   a. Thermal and physical properties of steam although based upon experimental data, permit accurate mathematical formulation, but the equations involved are complex and unwieldy for everyday use.
   b. Tables and graphical charts calculated and plotted from these laws offer a simple and accurate means of solving practically all steam problems without recourse to thermodynamic analysis.
2. Steam Tables
   a. Saturated steam conditions are tabulated for each deg temperature or psi absolute pressure.
   b. Superheated steam conditions are tabulated for each psi absolute pressure for given temperatures.
3. The Mollier Diagram
   a. The abscissa (horizontal axis) represents total entropy and ordinate (vertical axis) represents total heat (enthalpy) in Btu per lb.
   b. The saturation line represents dry saturated steam. 1. Conditions in the area below the saturation line are those of wet

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POWER ENGINEERING HANDBOOK

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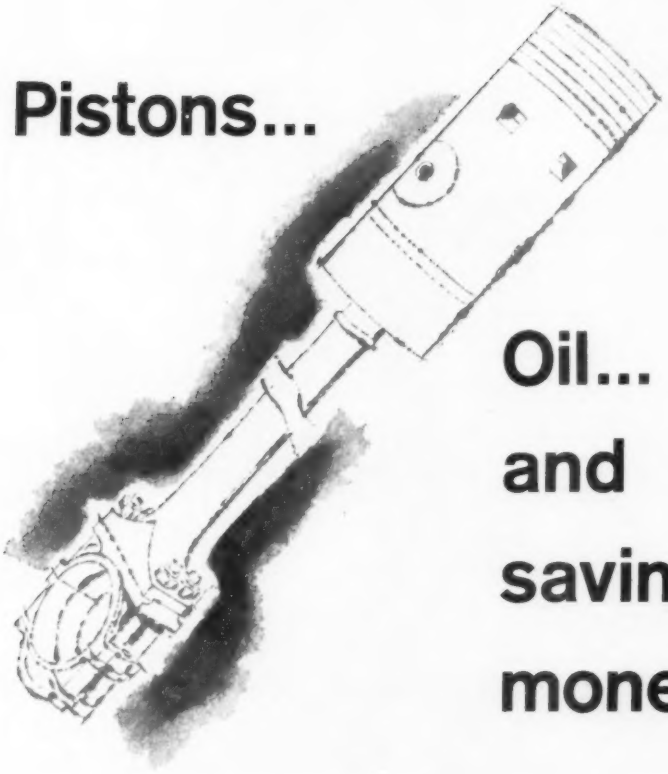
Pistons...



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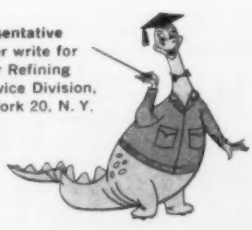

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steam. 2. Conditions in the area above the saturation line are those of superheated steam.

c. The intersection of any two lines (representing known conditions of the steam) locates a point from which other conditions of the steam may be determined.

Advantages of Superheated Steam

1. Increased Efficiency of the Prime Mover
   a. Moisture in steam reduces efficiency by reason of friction between the water and turbine parts.
   b. A larger proportion of the heat is utilized in the developing of power than for saturated steam. 1. In saturated steam much heat is lost in changing the condition of the working fluid. 2. This results in a lower heat consumption for superheated steam.
   c. Water rate of a steam turbine is reduced about 1 per cent for every 12 deg of superheat up to 200 F.
   d. When the superheat is high enough, it will supply the heat absorbed by piping and turbine parts, the heat equivalent of work done, and have dry steam at the exhaust. Excessive moisture in the steam causes turbine blade erosion.
2. Effect on Coal Consumption
   a. The additional heat necessary put in the steam is offset by an increase in over-all cycle efficiency.
   b. Increased economy of prime movers makes possible a reduction in size of boiler for a given capacity.
3. Reduction of Heat Losses
   Superheated steam makes possible a reduction in the size of piping.

Kraft Paper Used as Baffle Permits Inert Gas Welding in Field

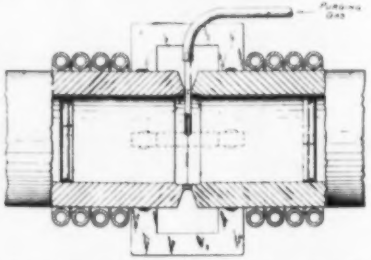
INGENIOUS USE of 50-lb kraft paper — the kind used for wrapping packages in retail stores — has been developed to make possible field application of inert gas welding methods.

Use of inert gas welding in the field of pipe for chemical, petroleum, power and nuclear plants has been limited by the difficulty in retaining the gas in the weld, then eliminating the retaining device.

By hitting on the use of a circular piece of kraft paper attached with masking tape as a baffle 6 in. from the ends of the pipe to be joined, Robert T. Pursell, metallurgical engineer with Stone & Webster Engineering Corp, is reported to have solved the problem.

The paper is able to withstand the pressure of three or four ounces an inch exerted by the inert gas and the welding heat of up to 600 F; but at the end of the welding process, during the annealing or stress-relieving phase, both the paper and the masking tape disintegrate, leaving the pipe clean.

According to Pursell, the new system results in strong and durable welds produced in the field at relatively low material and labor cost. The system makes it possible for welds to be made in any plane extending from the horizontal to the vertical. Actual practice has indicated that excellent welds can be obtained without the necessity of rotating or otherwise shifting the position of the pipes during welding.



Cross-section view of end section of two lengths of pipe, showing apparatus involved: bracketing device, tube for injecting inert gas, heating coils and the kraft paper baffles inside the pipe

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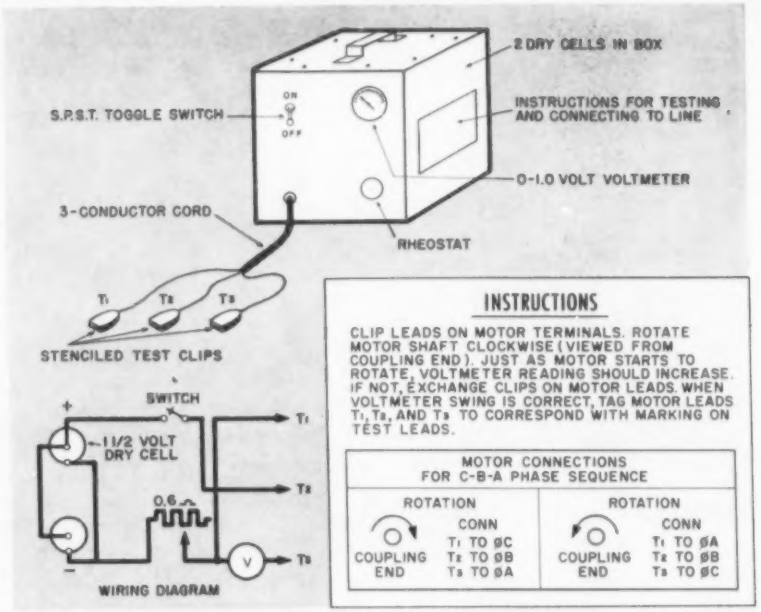


Here's a useful phase rotation finder for 3-phase induction motors. Diagram shows the connections, and the instruction panel can be attached to the case. Writer is associated with Union Electric Co. of Mo.

Phase Rotation Finder Does Away With Temporary Connections

By B. A. CORRADI

VERY OFTEN it becomes necessary to determine which motor leads must be connected to the supply circuit to insure that the motor will rotate in the proper direction when energized.

The phase rotation instrument shown here will permit the electrician to connect and tape permanently the terminals of the motor being installed, without making up a temporary connection and energizing from a power source to determine its direction, and if it turns out to be wrong, changing the leads to correct the error.

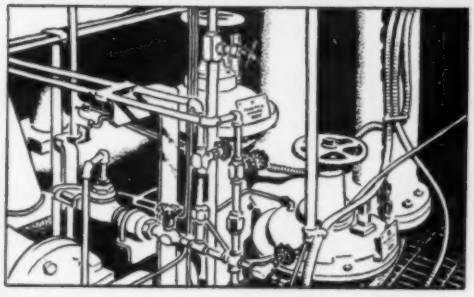
Such temporary connections can be time consuming, costly and quite hazardous, particularly where high voltage motors are involved. Certain types of drives should not be moved even a few degrees in their reverse direction; therefore, temporary trial tests have a 50–50 chance of being wrong, which can be serious.

Sketch shows the instrument in a metal case, and the wiring diagram shows the simple connections. The instruction procedure for operating the instrument is self-explanatory. These instructions may be attached to the side of the box and protected with a plexiglas cover.

cut along this line

Where metal costs less than plain water

SALTY, SANDY WATER IN CIRCULATION PUMP GLAND SEALS AT A COASTAL POWER PLANT CUT SHAFT SLEEVE LIFE BELOW 2½ YRS. USE OF FRESH WATER IN PACKING GLANDS WOULD HAVE REDUCED ABRASION, CORROSION. BUT THERE WAS A CHEAPER WAY. "S" MONEL® HARD-GRADE NICKEL-COPPER ALLOY SLEEVES, PRODUCED AT INCO'S BAYONNE FOUNDRY, WERE INSTALLED. NOW IN SERVICE 4 YEARS ...NO REPLACEMENTS...THE COST OF "S" MONEL SLEEVES WAS LESS THAN THE ESTIMATED COST OF PROVIDING FRESH WATER FOR LUBRICATION.



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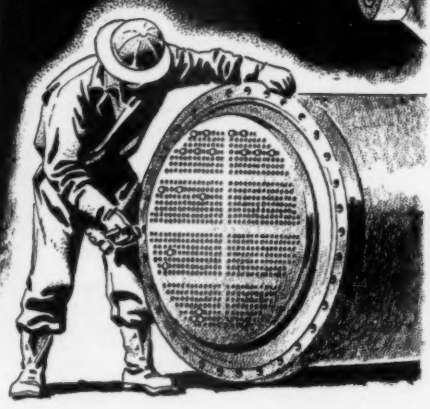
IT TAKES A MAZE OF SMALL TUBES TO PICK UP SAMPLES OF TREATED WATER, CAUSTIC SODA, AND WATER RINSES FROM AN ANION EXCHANGER. BECAUSE OF A CONSTANT CORROSION PROBLEM CAUSED BY ACID REGENERATION, MONEL ALLOY IS USED FOR THE TUBES, FITTINGS, AND FIXTURES THROUGHOUT THE SAMPLING SYSTEM OF AN EASTERN POWER PLANT'S NEW ION EXCHANGE SYSTEM.



Alloy Plugs for leaky heat exchanger tubes put an end to galvanic corrosion, too

PLUG'S SHAPE PREVENTS TUBE SHEET DAMAGE, MAKES CERTAIN PLUG IS DRIVEN IN CONCENTRIC WITH TUBE. OF MONEL* NICKEL-COPPER AND INCONEL* NICKEL-CHROMIUM ALLOYS, PLUGS ARE CORROSION-RESISTING AND GALVANICALLY COMPATIBLE WITH HEAT EXCHANGER TUBE MATERIAL.

SLOWED DOWN BY A METAL PROBLEM?

A TALK WITH ENGINEERS FROM INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU GET BACK ON SCHEDULE. JUST GET IN TOUCH WITH US AND OUTLINE THE DETAILS. AND FOR A USEFUL RUN-DOWN ON MONEL ALLOY, WRITE DEPARTMENT **PE** FOR 30-PAGE INCO BULLETIN, "ENGINEERING PROPERTIES OF MONEL AND 'R' MONEL ALLOYS."

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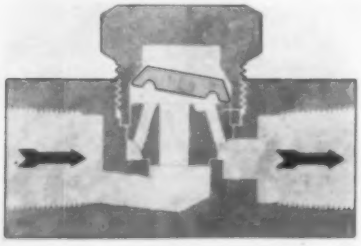
EQUIPMENT NEWS

1—pH METER designed for fast, continuous service

This compact line-operated pH meter is an electronic unit measuring 5½ by 6¼ by 2 in. It is designed for accurate determination of pH in raw, untreated, treated, potable, cooling and waste waters, boiler condensates, feed waters, oil field blends and brines. An auxiliary pointer is provided to enable checking of standardization without buffer solutions between measurements. Meter is claimed to be ready for operation 3 min after being plugged into a 100–125 v, 50–60 ac circuit. The meter covers a broad range of pH with high sensitivity, manufacturer states, and color, turbidity or chlorine in samples will not affect readings. Hagan Chemicals & Controls, Inc.

2—IMPULSE STEAM TRAP for for light condensate loads

Yarway 30 Impulse Steam Trap is designed for economy of operation and maintenance at light loads. The lever-type valve, which pivots about a fulcrum, discharges air and condensate at



full capacity at start-up time and snaps shut when steam reaches the trap, providing closer shut-off. Contributing to maintenance economy are a replaceable valve-seat assembly, one moving part, and stainless steel construction. The trap is suggested for use on steam tracer lines, steam main drips. It comes in ½-in. size for operating pressures 8 to 600 psig. Yarnall-Waring Co.

Reader Service Cards on pages 119–120 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

4—FLOW REGULATORS control variety of liquids and slurries

Measurement and control are incorporated within the Type F Flow Rate Regulator, which has two moving parts and operates with a pressure difference of less than 10 psi. It requires no outside source of power, no straight approach nor downstream piping section, has quick response with stability; and controls flow within 3 per cent of set point, despite fluctuations in line pressure, company states. Regulators are available in carbon steel, No. 316 stainless, and special alloys for flows from 0.02 to 550 gpm, with each size providing 15 to 1 flow rate adjustment by means of an individually calibrated linear dial. The W. A. Kates Co.

5—RUGGED LADDER resists weather and chemicals

Specifically designed for use in power, electrical work, this ladder is made by a process in which Fiberglas reinforced plastic is moulded over a balsa wood core. This is claimed to produce the toughest, most durable of ladders. Power tests to the ladder are reported to indicate no breakdown with 120,000 v applied between the rungs and 2900 v to rungs themselves. A safety feature is the non-slip, grit embedded Neoprene-coated rungs. These rungs will not twist because they are plastic welded to side rails, company says, and a 650 lb force is necessary to pull them away from side rail. The ladders are claimed weather proof, as well. Putnam Rolling Ladder Co.

3—A-C MOTOR designed to work outdoors in all weather

This weatherproof a-c motor is announced for use in applications where the motor is subjected to extreme moisture or the elements. An open motor, it is described as exceeding NEMA splash-proof requirements, having external parts of corrosion-proof cast iron. Shaft openings are sealed by a shaft cap and slinger. The non-hygroscopic insulation system features silicone sleeving, glass-mica slot liners and glass mat top-sticks and mid-sticks. Formvar wire coils are immersed in thermosetting, oil-and-water resistant varnish and sealed with red finishing enamel. Rotor OD and stator ID are coated with a rust inhibitor, and a non-washing grease is used in the Metermatic bearings, which meter the right amount of grease from the

reservoirs as needed. The watertight conduit box is cast iron with a gasketed cover and threaded outlet. Protective screening for ventilating openings may be had at no extra cost. Reliance Electric and Engineering Co.

6—GAS-FIRED UNIT supplies pre-heated make-up air

Designed to operate with natural, mixed, manufactured and propane gas, this air make-up unit is available in four unit arrangements in four sizes from 36 to 54 in. for various capacities, Btu ratings and pressure conditions. It is a self-contained package — only fuel and electrical connections are needed to place it in operation. A direct-fired burner and premixer assembly serve to maintain correct air-fuel ratios at all firing rates, and to assure uniformity of temperatures and quick response to changes in air inlet temperatures. Fan, burner and shutter assembly are automatically operated, and safety switches are provided. Aerovent Fan Co., Inc.

7—PORTABLE HEATER features built-in thermostat

For providing temporary comfort heat in maintenance shops, warehouses, boiler rooms and other unheated areas, this recirculating oil-fired portable heater is described as a furnace on wheels, complete with automatic electric ignition. You just plug it in and set the dial on the

built-in thermostat, company explains; this automatically turns the heat on and off to maintain a comfortable temperature. A fuel saver, this feature is claimed to let the heater run up to 30 per cent longer on a tank of kerosene or No. 1 or 2 fuel oil.

Other features announced are an electrically driven fan and enclosed combustion chamber designed to burn the fuel completely, producing maximum heat without odor or fumes. An air control is provided to compensate for variations in fuel, temperature or altitude, and a low-fuel cut-off switch is also provided. Six sizes range in output from 100,000 to 1,000,000 Btu per hour. Stow Mfg. Co.

8—BEARING GREASE stands high pressure, shock loads

Gulfcrown Grease E.P. is offered for use in bearing applications where high pressures and shock loads exist, or where there is a tendency for fretting corrosion to occur. This lubricant was formulated to meet severe conditions — as on steel mill rolls, oscillating shafts, rotary kiln bearings, crushers, gears, vertical swing shaft gear reductions. It can also be used as a multi-purpose grease, manufacturer states. It is said to have residual anti-weld properties and adhesive characteristics favorable for applications where infrequent greasing is practiced. It has excellent water resistance and good pumpability to below freezing, according to manufacturer, and will also serve industrial needs at high temperatures. A feature noted is that there is no separation of the oil soap base structure when subjected to high pressures in cen-

Refinery Power Plant Compares Bonnet Joints

No maintenance for Crane Pressure-Seal valve on 10-year high-pressure/high-temperature service

Ten years ago two 10-inch, high-pressure-temperature gate valves were installed in the power plant of a Midwest refiner. Each one was installed on a boiler lead line, where steam service is 900° F. at 1280 psi.

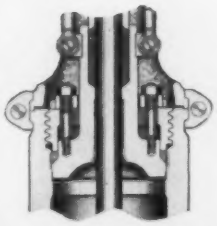
One valve is a conventional bolted bonnet type; the other, a Crane Pressure-Seal Bonnet Valve.

The bolted bonnet valve has required major maintenance four times in ten years because of bonnet joint leakage.

The Crane Pressure-Seal Bonnet Valve, during the same period, has never leaked . . . has needed no maintenance of any kind!

Conventional valves fight line pressure with heavy flanges and bolts at the bonnet joint. The bolting requires restressing and maintenance with each extreme change in temperature. Crane Pressure-Seal design harnesses line pressure to keep the bonnet joint tight despite extreme variations in temperature and pressure.

For complete information about Crane Pressure-Seal Bonnet Joint Valves—gates, globes, angles, stop-checks and swing-checks—in 600, 900, and 1500-pound classes—call your Crane Representative, or write to address below for new Circular AD-2336.



Here's the Crane Pressure-Seal Joint that eliminates bonnet joint leakage and maintenance on high-pressure-temperature services.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

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tral lubricating system. Gulfcrown Grease E.P. comes in three N.L.G.I. consistencies, all reported to have good oxidation and mechanical stability and rust protection. Gulf Oil Corp.

9—PURGE VALVE removes gases and liquids from lines

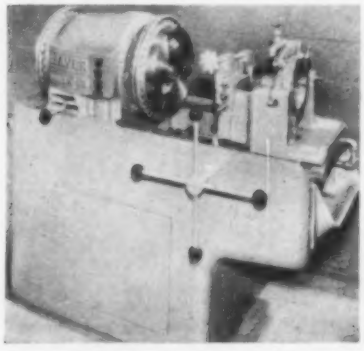
The Nupro Purge Valve is designed to assure maximum operation under practically all conditions, including corrosive application. Features announced include an effluent removal passage for gas or liquid escape directed away from the operator; ball and seat designed to provide a tight seal, yet prevent ball from sticking even after non-use; easy-opening knurled cap attached to the body. A marking notch on the cap indicates direction of discharge when valve is relatively inaccessible. Valves are available for installation in male and female pipe threads, AN fittings and compression fittings in sizes from ¼ to ½ in, and in brass, Monel, stainless steel, aluminum, Teflon and other materials. Nuclear Products Co.

10—WATER TUBE BOILER with forced draft burner

In this new Compak series of forced draft boilers, water tube construction is coupled with multi-pass design for rapid steam or hot water generation and thermal efficiency. These boilers are described as fully automatic oil/gas fired package units. Access is provided to both the fireside and waterside of all tubes without dismantling the boiler. The sweeping action of hot gases over the outer surface of the water tubes makes the boiler virtually self-cleaning, it is pointed out. Units are available for low or high pressure hot water or steam generation in capacities to 100 hp. The International Boiler Works Co.

11—THREADING MACHINE offers greater versatility

The Speed-King is a ½- to 4-in. pipe and bolt threading machine weighing only 980 lb and designed to cut, thread, ream, groove, chamfer or bevel pipe, die head



and cutoff carriers throw out. An added feature, for those who wish to make up flanges and fittings in the rear of the machine, is a step-block chuck with rocker grip inserts like those in the front. With the Speed-King it is possible to thread ½- to 4-in. pipe with only three die heads, manufacturer points out, and it is never necessary to change dies. Four spindle speeds range from 19 to 74 rpm. Beaver Pipe Tools, Inc.

12—SNAP-ON INSULATION is crushproof, light in weight

Low K factor, excellent resistance to physical damage and to chemicals and solvents are claimed for snap-on urethane insulation. Based on Nacconate diisocyanates, this insulation is designed for service between −200 F to +250 F. It is suggested for refrigeration work and low pressure (5 psig) steam lines. It is pointed out that urethane insulation does not fray, crumble or break in handling — or disintegrate when subjected to water or many other liquids. Another feature announced is that it is performed to fit pipelines and fittings. The outside diameter is such that it will nest with a second layer, in case heavier thicknesses are desired. The dual-layer procedure also permits staggering of joints to reduce heat loss. Only one seam is required for the urethane foam insulation. It deforms to be slipped over pipes and fittings, then snaps back to its original shape. It normally comes with a factory-applied moisture vapor barrier, but may be supplied with a felt paper jacket for outdoor use. It comes in preformed sections as well as flat blankets. Allied Chemical Corp.

13—LIQUID LEVEL CONTROLS, for precise regulation

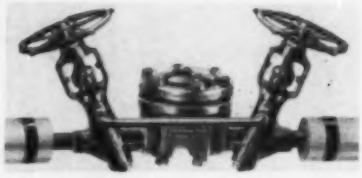
Models A-152-F and A-153-F are single-stage, narrow-differential liquid level controls. Small movement between make-break contacts is said to provide high sensitivity to level change. They are designed to control liquids of specific gravity 0.30 and up, temperatures to 500 F, pressures to 5000 psi. Displacers are available in many materials including Karbate, porcelain, and stainless steel. Stainless steel inter-face applications are also possible. Magnetrol, Inc.

14—LUBE KIT for routine rotary switch maintenance

This kit — about the size of a package of cigarettes — contains lubricants for routine maintenance of rotary stepping switches. In the carton are three 2-dram bottles. Removal of the carton top leaves the bottle upright, ready for use. Lubricants provided are those recommended by manufacturer for use in its industrial rotary stepping switches. They are: blended lubricating oil (Spec. 5684), essentially a mineral oil blended with an oil having a paraffin base; watch oil (Spec. 5228), a refined grade of selected sperm or fish oil; and graphite-oil lubricant (Spec. 5232 — Grade C) consisting of a blended lubricating oil and deflocculated graphite. The kit sells for less than $3.00. Automatic Electric Co.

15—SOLDERING ROD for aluminum, joining, filling

Airco 720 Al-Solder Rod is an alloy specifically designed for soldering aluminum easily, efficiently and economically. It is announced as providing a good color match and as being clean to use, requiring no flux, no washing and no wire brushing. Pre-cleaning and post cleaning are unnecessary, company states. The rod is claimed particularly applicable for filling porous aluminum castings, for joining aluminum air ducts, aluminum foil and aluminum tubing, and for soldering galvanized sheets. This solder is applied by rubbing across joints which have been heated. Flame is not directed on the rod. Melting and wetting takes place at 400 to 500 deg below melting point of the aluminum at 720 F. Air Reduction Sales Co.



16—TRAPPING UNIT simplifies installation, maintenance

The Piping King is described as a valve combination assembly for use where bypass piping is required for steam trapping. This assembly is designed to perform the functions of steam trap, strainer, air vent, check valve, shut-off valves, test and blow down plug. According to manufacturer, installation involves only two joints and a half hour's time. The Piping King is installed as a unit in all positions and is claimed freezeproof in vertical position. Major components in the assembly are company's forged steel universal steam trap and forged steel bonnetless valves. Velan Steam Specialties Inc.

17—CLOSE-COUPLED MOTOR for pumps built to NEMA standards

Tri-Clad 55 Motors, standard and special, from 7½ to 100 hp, feature a solid cast rotor, cast iron frames and permanumbered leads for quick identification with weight reductions up to 33 per cent easier installation. A labyrinth seal on both sides of the housing serves to keep grease in and dirt out; and a standardized shaft extension and C-face end shield reduce the number of parts often required to meet a wide range of ratings. General Electric Co.

18—HELICAL GEAR DRIVES in capacities to more than 200 hp

Larger sizes of double and triple reduction drives and a quadruple reduction helical gear drive have been added to this company's In-Line Helical Gear Drives. Capacities to more than 200 hp are available. The compact quadruple reduction speed reducer, in five sizes, extends the range of ratios as high as 2,217 to 1. The simple gear arrangement of these speed reducers consists of helical gear trains operating in high capacity ball and roller bearings in a cast iron

"Package" ion exchange equipment for lab or pilot plant . . . from stock

Laboratory ion exchange column

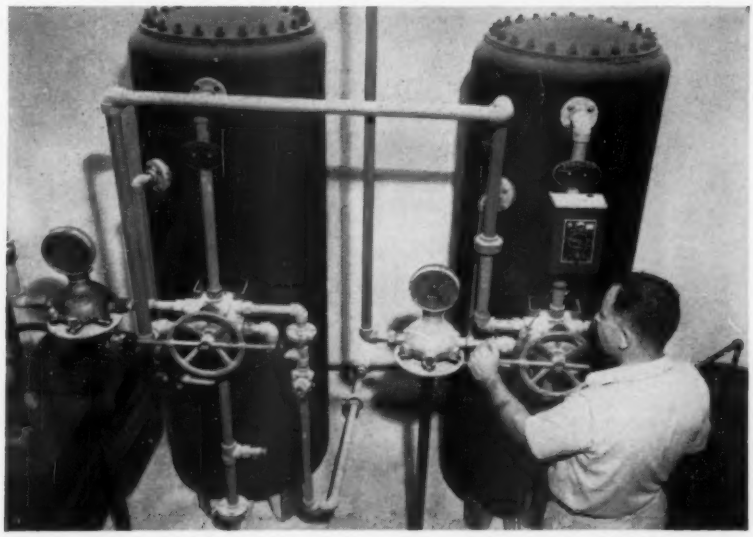
The Permutit laboratory or lecture-table kit includes a 1½" O.D. glass tube with one end drawn down to fit ordinary laboratory rubber tubing, the ion exchange resin or resins required and literature describing ion exchange experiments. The user supplies the

stand, clamps, tubing, stoppers and beakers. The tube will hold sufficient Permutit Q ion exchange resin to remove 20 to 25 grains of hardness.

This simple set-up is used for demonstrating ion exchange processes such as softening, dealkalizing or demineralizing water and for experiments in removal of impurities from process solutions and separation of metals from leached ores or waste liquids.

MBD-6A mixed bed demineralizer

The MBD-6A unit (6" diam.) contains a mixture of Permutit Q cation exchange resin and Permutit S anion exchange resin. It will demineralize 1 to 2 gpm of water to a low total solids, low CO_2 and low silica content. Refills containing pre-mixed resin are available. Each refill has a capacity of approx. 1500 grains total electrolytes as $CaCO_3$. When the unit is exhausted, the fill may be discarded or regenerated and re-used.



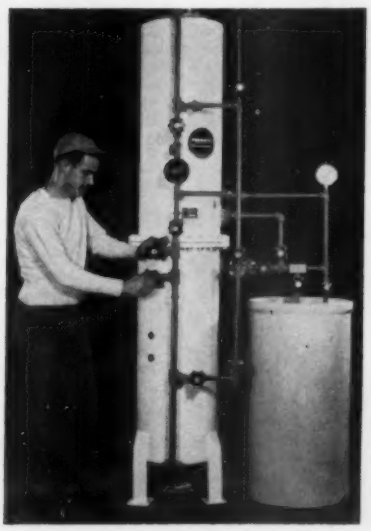
A conductivity cell is mounted in the outlet line to be used with a conductivity meter for measuring the electrolyte content of the effluent and thus indicating when the resin bed is exhausted.

Standard equipment includes the MBD-6A with initial fill, faucet adapter and hose and conductivity cell. Optional equipment: conductivity meter, resin refills and an auxiliary tube for regenerating the resins.

MBD-15 mixed bed demineralizer

This compact unit will demineralize 6 to 7½ gpm of water to an average conductivity of 0.15 micromhos (approx. 6,000,000 ohms specific resistance per cm or 0.05 ppm total electrolyte content). CO_2 will be reduced to 0.1 ppm and SiO_2 to about 0.1 ppm.

Capacity of the MBD-15 between regenerations is approx. 20,000 grains total electrolytes. For example, it will demineralize



3420 gallons of water containing 100 ppm total electrolytes or 1710 gallons containing 200 ppm total electrolytes. When the unit is exhausted, the resin bed can readily be regenerated without removing the resins from the tank. The plastic regenerating tank is used for both regenerants.

The MBD-15 is supplied piped and partially assembled and requires connecting together only 3 flanges other than the connections to influent, effluent and waste lines.

16", 24" and 30" diam. single bed units

(see photo above)

Diameter of unit	16"	24"	30"
Approx. flow rate (gpm)	10	20	30

Construction of these "package" units is of the same heavy-weight materials used for Permutit's large custom-designed units and includes rugged PVC plastic interior piping and plastic strainers, full 3/16" thick rubber lining steam-cured and vulcanized to the heavy gauge steel shell. The entire lining is spark-tested at 25,000 volts. Exterior piping is high strength plastic.

Standard equipment includes a rubber-lined Permutit multiport control valve for each unit, acid pump, corrosion-proof plastic tank for cation regenerant and steel tank for anion regenerant. All parts are normally kept in stock for immediate shipment and are described in standard drawings.

• • •

For complete information, write to The Permutit Company, Dept. PE10, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

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housing. Space requirements are minimized by locating input and output shafts in the same horizontal and vertical planes. Automatic splash lubrication of moving parts is provided. Folder 2651A gives data. Link-Belt Co.

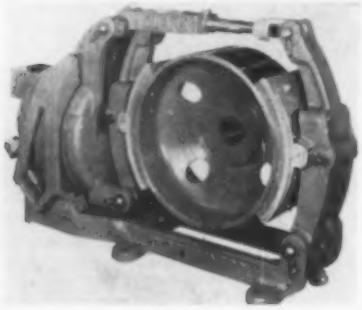
19—TRANSMITTERS measure differential pressure and flow

These force balance transmitters measure and pneumatically transmit flow, differential pressure, level and specific gravity over wide ranges. They measure over a minimum range span of 0–2 in. water under service pressures to 50 psig, to a maximum span of 0–2000 in. water under service pressures to 5000 psig. No viscous or other dampening devices are needed, it is noted; stability is maintained by a reset type booster relay.

When a pneumatic signal, varying linearly with rate-of-flow, is required for recording on the same chart with other linear quantities, or for integrating, and/or control purposes, the transmitter has a built-in square root extractor. This flow transmitter, which may be mounted on the process piping, is reported particularly useful as one element of a multi-element control system. Its linear rate-of-flow signal combines with pneumatic signals from other linear transmitters. Three standard measuring diaphragms provide all ranges. Ten-to-one differential range change is possible with screwdriver adjustment. Product Specifications P21-7 and P22-2 describe these force balance units. Bailey Meter Co.

20—D-C MOTOR BRAKES offer simplicity of adjustment

The Bulletin 106 line of d-c brakes is announced as featuring high rigidity, simplicity of adjustment, and easy servicing without disturbing torque adjustment. It is designed to meet NEMA-AISE standards for use with NEMA 600 series mill-type motors and equivalent sizes of standard motors. This brake utilizes a "nut-cracker" design, hinged

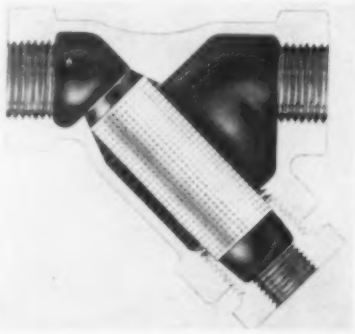


at top, for equal distribution of applied pressure. The mounting method used holds shoes in spring-loaded sockets without depending on pins to connect them to the arms. A partial turn of a wrench releases pressure so shoes can be slid out to the side without removing the wheel. Brake shoes are self-aligning and interchangeable end-for-end and with each other.

Maintenance adjustments are made from the top of the brake, it is noted, and all adjustment, maintenance, assembly and disassembly can be accomplished with screwdriver and wrench. Of cast steel construction, with cast aluminum shoes, the brake has pressure lubricated Nitralloy bushings and hardened pins. Clark Controller Co.

21—PIPELINE STRAINER is self-cleaning unit

Features announced for the Type AT Strainer are high strength construction of the semi-steel (ASTM-A48-48, class 30) bodies, an internal design that assures tight fit of the screen cylinder with-



out buckling, perforated heavy gage screen with spot welded lap seams for maximum rigidity with smooth inner surfaces, and built-in sediment collection chamber integral with cap. The 45-deg design facilitates clearing by blow-off. The strainer is rated for saturated steam or liquids to 250 psi and 475 F total temperature. It is available in sizes from ¼ through 3 in. Sarco Co.

22—TANK SUCTION HEATER for underground storage

Paracoil Model VU is a vertical type tank suction heater designed to simplify inspection and servicing in below-ground storage installations. It is a U-tube heater suspended vertically into the tank from a support plate on a nozzle at the top of the tank. Hot water or heat transfer liquids are heating media. Service connections are outside tank in an access chamber entered into at ground level. Only the heating tube bundle and its shell lies inside the tank. Top end channel, to which the heating medium circulating lines are connected, can be removed to expose the tube ends and sheet for inspection. Entire tube bundle can be removed without breaking product lines, it is noted, and only normal depth from ground level is required.

A self-venting suction chamber is built into the bottom of the heater shell, where hot return product mixes with fresh product being drawn from the tank providing an initial temperature increase even before heating tubes are reached. Heater comes in standard sizes and capacities. Davis Engineering Corp.

24—DUST COLLECTORS, improved multiple-tube types

Two new designs of the Cyclo-trell, multiple tube type mechanical dust collector, retain the cyclone tubes with minor improvements. One of the new arrangements provides for entry of uncleaned gases horizontally through a side inlet. Cleaned gases flow out of the collector through a universal outlet. The outlet flange is constructed so that outlet ducts or flues may be connected for gas flow at any angle. The universal outlet provides greater flexibility in placing the collector in a gas cleaning system and in designing outlet flues.

In the second new design, uncleaned gas enters the collector through an inlet in the top and leaves through a side inlet. Both designs come in various capacities. The smallest utilizes a single row of three tubes and the largest 24 rows of tubes 14 tubes deep or a total of 336 cyclone tubes. Tubes are arranged in rows of 3 to 14. Previously the Cyclotrell has been available with a side inlet and a side outlet. The cyclone tubes have both a higher collection efficiency and a greater capacity rating than conventional multiple tube collectors, according to company, and the greater capacity rating permits fewer tubes per installation. Research-Cottrell, Inc.

25—CIRCUIT BREAKERS provide worthwhile space savings

These two molded-case circuit breakers are described as providing 225- and 400-amp continuous-current rating in two-thirds the space formerly required. Designated JK and JKL, these breakers provide on a small J-frame the protection previously available on larger K and KL frames, manufacturer states, and at the same or lower costs. They come in both two- and three-pole models with interrupting ratings of 25,000 amp at 600 v. a-c. They are announced as UL approved and as offering features and advantages of company's entire molded-case line plus two new ones for this breaker size range.

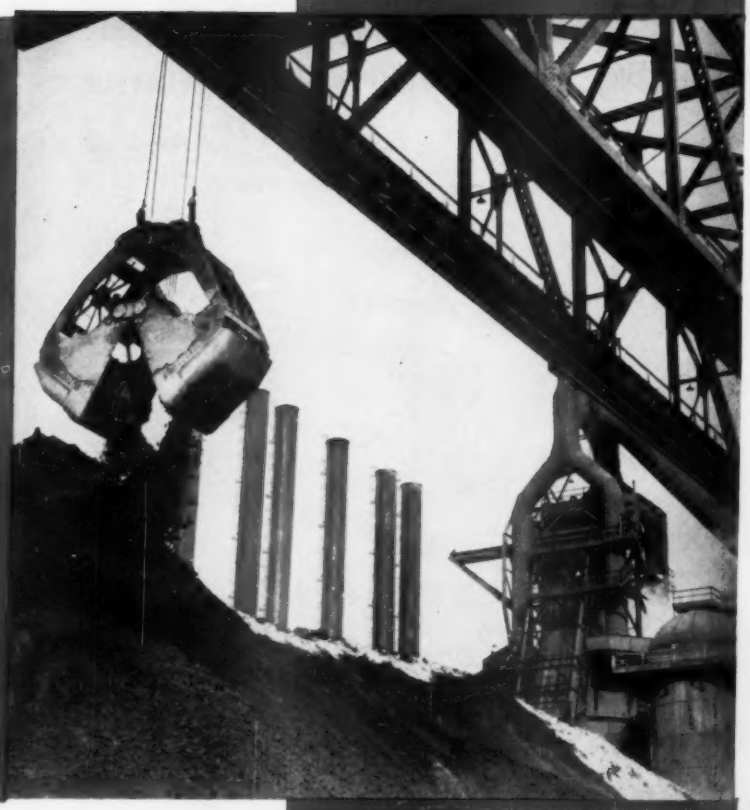
First of these features is interchangeable thermal-magnetic trip units which can be set at five different instantaneous trip valves and may be adjusted from front panel after breaker installation. The second advantage is a front-removal lug design for fast, simple interchange of trip units after the breaker has been installed. These breakers are quick-make-and-break and trip-free, says company, and all poles open simultaneously through common trip action when overload occurs on any pole. A three-position handle indicates if breaker is on, off or tripped. I-T-E Circuit Breaker Co.

23—FLOW METER offers easy maintenance

This general purpose flow meter, the Series 5000, is designed for accurate measurement of flow rates with new standards of float stability. It also features a quick-out flow tube. An advantage announced is outstanding stability, attributed to the Tapor-Flo principle utilized — the float lines out quickly without bobbing, to permit exact reading of flow value without visual averaging. Float height is directly proportional to flow rate, and flow value is indicated on a graduated scale etched into the side of the flow tube.

Due to the inherent simplicity of the Tapor-Flo design, maintenance is reported easy and inexpensive. Only bottom adapter need be unscrewed to allow the tube to be pulled out for cleaning or for meter capacity change (by replacing float. Capacity depends on specific gravity of fluid, size of

Why Mead-Morrison Coal and Ore Buckets move more material



Mead-Morrison buckets are constructed almost exclusively of lightweight, high-tensile alloy steel that provides maximum payload per pound of bucket weight, less load on the structure, lower power consumption and high resistance to abuse.

They are designed for greater ease of penetration and digging power.

Low maintenance results from design and proper use of high strength material in the bucket. Its riveted—not welded—construction maintains proper shell contour and correct alignment and facilitates field repairs.

A new patented, *non-jamming* jaw linkage is available that obsoletes all other hinge types in the handling of non-crushable material.

The next time you are considering replacing a bucket remember that *the bucket moves the material.* Cheap, heavy buckets down-rate your entire system. The higher capacity per pound of bucket weight and the strength of Mead-Morrison buckets guarantee that your overall system is operating at maximum efficiency.

For detailed literature on Mead-Morrison buckets write to: . . .

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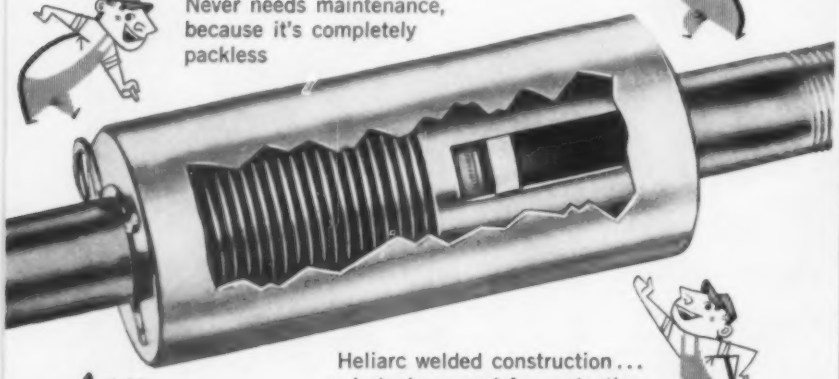
HIGH-PRESSURE, HEAVY-DUTY EXPANSION COMPENSATOR

Inch for inch, the lowest-cost way to take care of pipe motion

Never needs maintenance, because it's completely packless



Heliarc welded construction... and steel-encased for protection from external damage

Its 2-ply stainless steel Flexon bellows is designed to outlast the building

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You can bank on it . . . Flexon Model H Expansion Compensators cost much less per inch of stroke than *any other method* of absorbing pipe expansion! Yet the Model H is built for hard service, with its 2-ply stainless steel Flexon bellows, positive internal guide and anti-torque device, and full protection from external damage.

This is why engineers and piping contractors are specifying the Model H for thousands of industrial piping jobs—in heating systems, process piping, steam tracing, power piping—that use pipe up to 3" and require up to 2" total movement at each Expansion Compensator. Working pressures to 175 p.s.i. for ¾" and 1" sizes; to 125 p.s.i. for larger sizes up to 3".

Make the Flexon Model H Expansion Compensator a cost-cutting part of your next piping job. Write for design and cost data, and the name of your Flexon representative.

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flow tube, and flow weight. Standard meters range from 0.0001 gpm to 30 gpm of water. With glass jacket, Series 5000 Meter working pressure varies with meter size. Rating for ¼-in. meter is 250 psi at 70 F. Maximum operating temperature is 250 F. For pressures to 1000 psi, a stainless steel jacket is furnished with top-magnetic readout. This readout feature is also used with dark liquids that would obscure the meter scale. C-Mar Corp.

26—BUS CONDUCTOR offers simple, low cost installation

Alcoa Universal Angle Bus Conductor is announced as a lower-cost substitute for smaller sizes of tubular bus conductor. This product, an L-shaped extrusion, was developed to provide a bus conductor adaptable to normal cable lug connectors and it brings new features to an old conductor shape — the structural angle. Built into it are shallow longitudinal

grooves. On the outer surfaces of the bus, two extruded grooves locate the center points for drilling holes which receive a standard connector, or for direct connection to station apparatus. On inner surfaces, a single groove locates the center line, so bus may be drilled to connect directly to insulators.

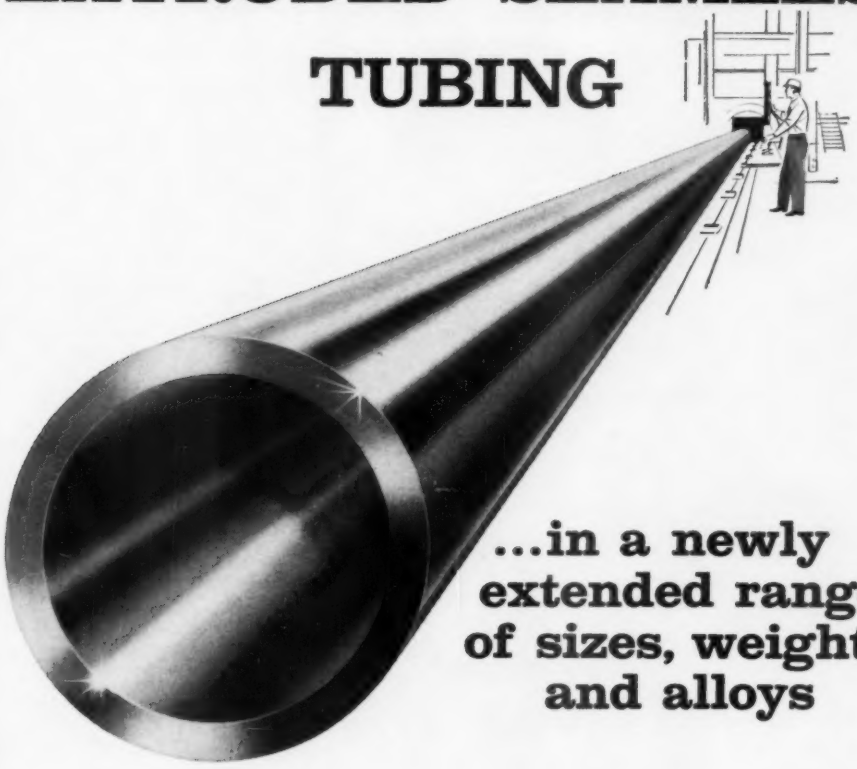
The new bus was designed primarily for use in distribution-type substations; it is also suggested for sub-transmission voltages, and for primary distribution voltages. Although used normally where current ratings are in the 700-800 amp range, UABC in the presently available 3¼-by-3¼-by-¼ in. size is rated 1300 amp. Where two such angles are used back-to-back, mounted directly to insulator caps and separated ¼ in., the resulting current rating is about 70 per cent higher than for a single conductor. Aluminum Co. of America.

Described on these pages are new and improved products. Use Reader Service Cards on pages 119–120 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

27—CONTROL EQUIPMENT designed for sub-stations

The a-c or battery-powered Circuit Scanners are announced as safe and efficient supervisory control for sub-stations. Because the control equipment is powered from a separate source independent of the equipment being monitored, systems are safer to use with little

Curtiss-Wright
EXTRUDED SEAMLESS
TUBING



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- Sizes from 8 through 20 inch outside diameters, and even larger, in quarter inch increments.
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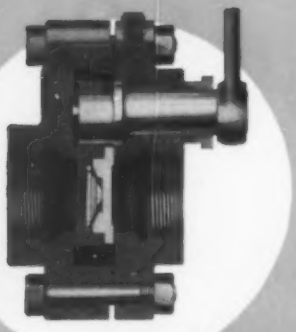

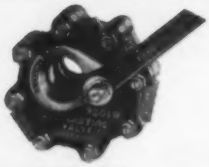

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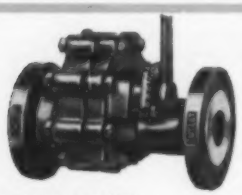
Quick acting, also handwheel operated "Y" and angle types. For pressures up to 600 psi.



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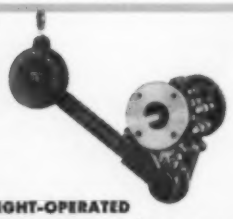
Can be remotely controlled, electrically or manually.

STEAM JACKETED
Assures free flow of viscous materials.



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For automatic drains or emergency shut off.

When you want

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- minimum pressure drop
- straight-through full flow
- self-grinding rotating disc
- valves that cannot wedge or jam

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No other valve has all the Everlasting features . . . proven by half a century of service to assure dependable, leak-tight service.

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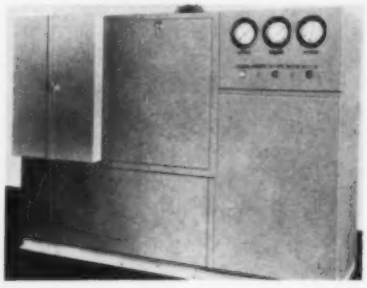
chance of simultaneous power failure, company states. Systems may be installed to operate all on a-c power or a-c with standby battery or all battery-powered; regardless of power used, the system will be in synchronization. Circuit Scanners are reported low in cost, easy to install and reliable. Using a single pair of wires, any number of stations may be wired to a central control cabinet in a single system. It is designed to provide supervisory control with manual or automatic on-off operation of all of the circuit breakers in the substation. Femco, Inc.

28—METAL CONDUIT is flexible and liquid-tight

Sealed Skin, designed to meet J.I.C. requirements, is announced as a liquid-tight flexible metal conduit for waterproof electrical conduit applications, construction, heating and air conditioning equipment, automated lines. Its galvanized steel core, made from continuous strip metal, is covered with polyvinyl chloride to protect against oil, weather, water, dirt, chemicals, fumes and salt spray. Claimed easily installed, even in U-bends or crowded quarters, Seaked Skin is adapted to providing connections between a moving member and stationary part. It can be cut to size on the job and is said to resist vibration. Nine sizes from $\frac{3}{8}$ to 4 in. are available. The International Metal Hose Co.

29—PACKAGED FIRING UNIT for oil and/or gas fuels

This automatic steam atomizing unit is announced as featuring electric-gas ignition, modulation fire control, damper

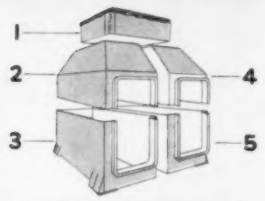


sequence control, forced draft combustion air, electronic combustion safety supervision, mechanical atomizing (steam assisted internal mixing oil burner, and ring or cylindrical type gas burner for gas fuel). Bulletin 28 gives details. National Airoil Burner Co., Inc.

30—HEAT EXCHANGER for liquid, gas cooling, process use

Evaporation of a water spray over the cooling coil provides the cooling effect at the rate of about 1000 Btu per pound of water evaporated in this new model of the Aero Heat Exchanger, Series 44-HOO. The air stream, in which the heat is rejected, enters near the top of one side, travels down through the spray chamber and is drawn upward through the plenum and discharged by propeller fans. The fluid is cooled to a point close to the atmospheric wet bulb temperature and the control of temperature is automatic, governed by modulating amount of air flow of fresh or recirculated air.

This 75,000 square foot condenser pre-assembled and pre-fitted at Maryland was shipped in 5 compact maximum rail clearance sections.



5-piece Maryland condenser design

Horizontal division separates the neck section (1). The main body of the condenser is divided both vertically and horizontally, as shown by sections numbered (2), (3), (4) and (5).

Maryland's 5-Piece Condenser

Designed for Low Cost Field Erection

Maryland designed, built, pre-fit and pre-assembled this 75,000 square foot condenser in five compact sections for accurate and low cost field erection.

Now being installed at Reesedale, Pennsylvania in West Penn Power's Armstrong Station, this unit indicates Maryland's ability to engineer and build large surface condensers for electric utilities. It will condense 812,819 pounds of steam per hour exhausted from a 156,250 KW Westinghouse turbo-generator, and its full deaerating hotwell will produce condensate with no more than .01 cc of oxygen per liter.

When *your* plans call for steam surface condensers, consider the advantages offered by Maryland's years of engineering experience and facilities for designing and manufacturing condensers, of any size.

Industrial Products Division

MARYLAND SHIPBUILDING & DRYDOCK COMPANY

BALTIMORE 3, MARYLAND • *Representatives in Principal Cities*

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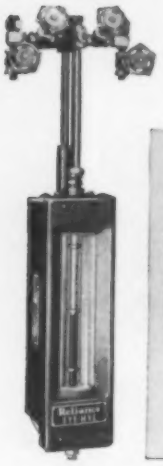
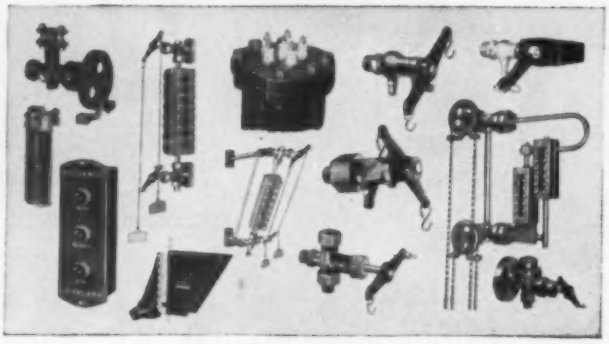
For new plant or modernization

...you'll be wise to select...

Reliance
water columns, gages and alarm devices.





Plan wisely for completely safe water level supervision on all boilers, and all water-containing vessels, with rugged, efficient Reliance equipment. This specialized line includes water columns for any type of boiler—*any pressure*—and complete trim, including various types of gage inserts, direct-to-drum assemblies and illumination; remote gages, auxiliary alarms and automatic controls.

Known the world over for accuracy, sturdiness and dependability, Reliance equipment brings you the advantages of trouble-free low-maintenance service. For keeping your plant in the best of trim now, or for planning new or revised power facilities, keep posted on the latest in Reliance Boiler Safety Devices.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

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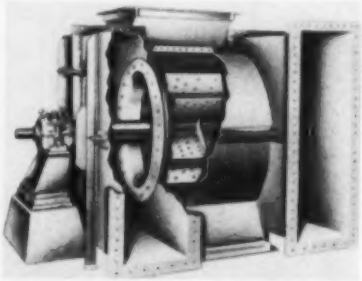
Heat is removed at the rate of input. Special features announced include completely cleanable coils and "winter-summer" dampers that permit outdoor installation in severe climates. Available capacities range up to 18,000,000 Btu/hr under standard conditions. Suggested applications include: water, oils, solutions, others. Niagara Blower Co.

31—HEAVY DUTY FANS stand heat and abrasive gases

Series 7000 Fans are mechanical draft fans designed for handling abrasive gases at elevated temperatures. In ratings to handle 10,000 to 500,000 cfm and pressures up to 70 in. of water, these centrifugal fans are designed to operate in a range from 20 to 850 F. They are made specifically for application where



either abrasion or temperature requires radial blading with heavy tapered-blade sections for minimum stress of rotating parts. These include steam boiler gas recirculation, fly ash precipitator purging, induced draft for waste heat boilers, and similar processes.

Unobstructed gas passage over open radial blades provides self-cleaning action; ribbed blade lines are used for extra severe abrasive service. Housing and inlet boxes for these fans are welded steel with quick-opening access doors, braced for working pressures. Sturtevant Div., Westinghouse Electric Corp.

32—CONTROL SYSTEM for the unit ventilators

An all-electric package control system for face and by-pass type unit ventilators, the Dual Element Controller consists of a motor operator for damper control actuated by its own self-contained dual temperature sensing elements. It combines the function of thermostat and controller in a single pre-wired package. Manufacturer says it is inherently positive positioning, and its high torque rating assures accurate positioning of unit ventilator damper mechanism. The proportioning motor operator has a rugged return spring for closing the outdoor air damper whenever the unit ventilator is shut down.

The Dual Element Controller utilizes two fast responding coil type sensing elements: one for room air temperature, and the other, an averaging type, for discharge air temperature. The controller is mounted within the unit ventilator housing. Its room air sensing element is in a sampling chamber. This control package is specifically designed for control of face and by-pass unit ventilators when used for hot water and chilled water heating, ventilating and air conditioning use. Barber-Colman Co.

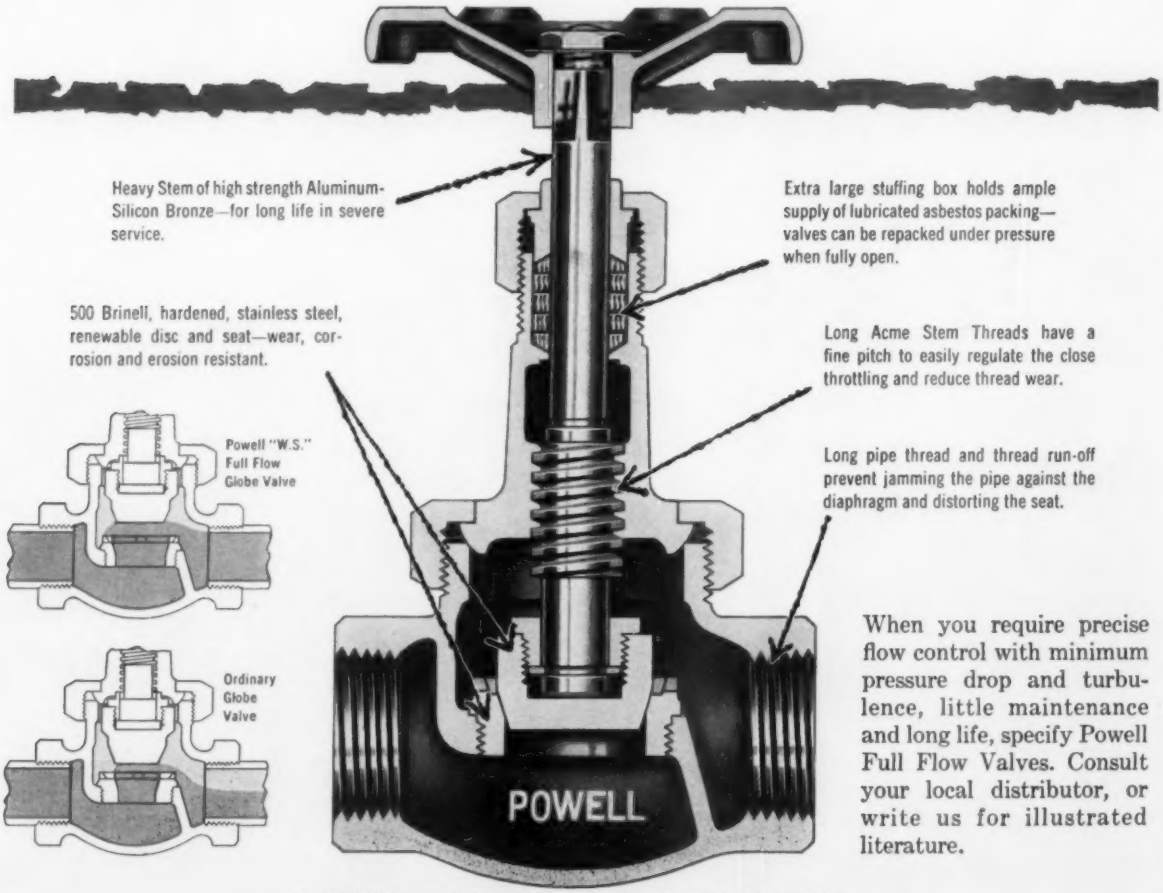
BULLETIN!

POWELL introduces new member in world's largest family of valves

Powell engineered "Full Flow" bronze valves are now available in a full line: the brand-new 150-pound screwed end Globe Valve, in addition to the well-known 200-300 pound Screwed and the 150-300 pound Flanged Globe and Angle Valves.

Although designed by Powell to assure maximum flow with minimum pressure drop and internal turbulence, these valves can be throttled to permit only the minutest amount of fluid to pass through. And, if desired, they can be supplied with Indicator Collar, Arm and V-port Disc for quickly determining flow and holding it constant.

Compare these advantages of Powell Full Flow valves:


Heavy Stem of high strength Aluminum-Silicon Bronze—for long life in severe service.
Extra large stuffing box holds ample supply of lubricated asbestos packing—valves can be repacked under pressure when fully open.
500 Brinell, hardened, stainless steel, renewable disc and seat—wear, corrosion and erosion resistant.
Long Acme Stem Threads have a fine pitch to easily regulate the close throttling and reduce thread wear.
Long pipe thread and thread run-off prevent jamming the pipe against the diaphragm and distorting the seat.
Powell "W.S." Full Flow Globe Valve
Ordinary Globe Valve
POWELL

When you require precise flow control with minimum pressure drop and turbulence, little maintenance and long life, specify Powell Full Flow Valves. Consult your local distributor, or write us for illustrated literature.

Fig. 2600 (Sectional)—150-pound "W.S." Full Flow Globe Valve, Screwed Ends

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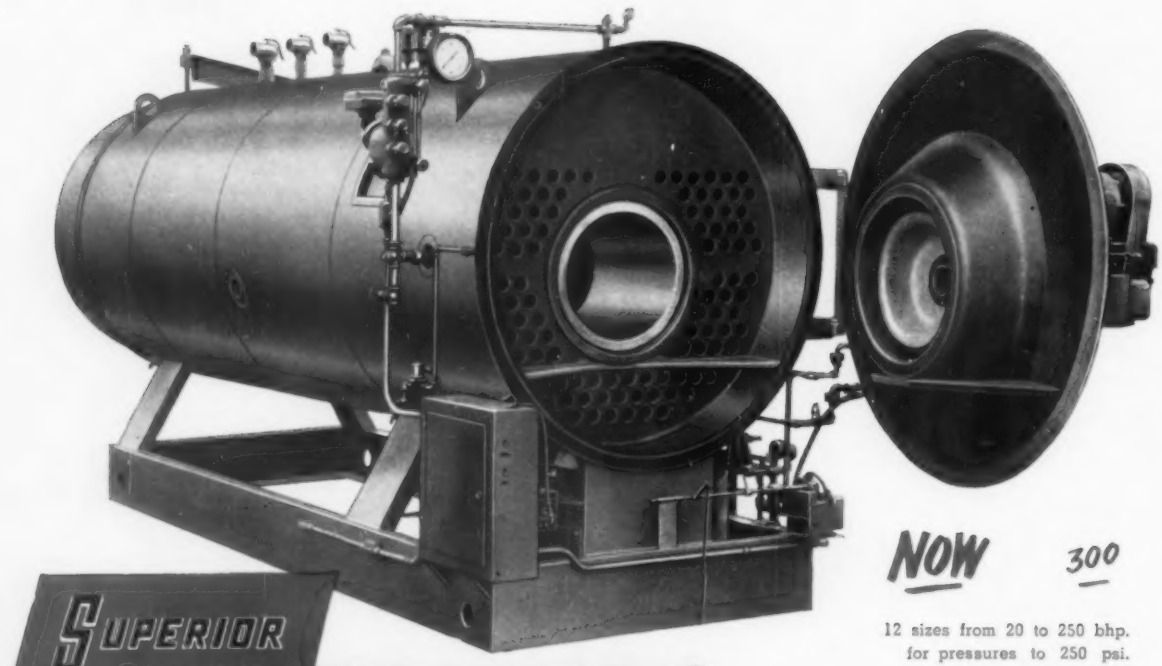
NOW GREATER CAPACITIES in Smaller Space



NOW 300

12 sizes from 20 to 250 bhp. for pressures to 250 psi. or for hot water. Fully automatic operation firing oil or gas or both. Before you buy or specify any packaged boiler, get the details in Bulletin 1006-C

SUPERIOR "COMPACT"

all the big boiler features you want combined with accessibility and easy maintenance

With a full 5 sq. ft. of heating surface per bhp., 4-pass, down-draft design, and built-in induced draft, the Superior COMPACT is a highly efficient and dependable package. Its efficiency, guaranteed by factory-fire-test of every unit, insures years of economical performance; for the Superior COMPACT is planned for the easy maintenance which sustains high efficiency.

Front doors are hinged, and rear doors hinged or davited to simplify inspection and cleaning. But note that no belts or mechanical components are located inside the front door where they would be subject to the heat of the fire. All units firing #4, #5 and #6 oil are equipped with dependable Superior Rotary Burners. High in the shell, and protected by the tubes of the fourth pass, the furnace is away from the "danger zone" eliminating the possibility of bagging or blistering.

Specialists in PACKAGED BOILERS... exclusively

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

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PUMPS, PUMPING

201 For Abusive Pumping Jobs — This Pump Selector covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

202 Non-Clog Pumps — Bulletin 121MV features Mono-Vane single passage impeller pumps designed for handling heavy settleable solids, long stringy solids, effluent etc. Both horizontal and vertical types are presented along with specifications. Mono-Vane impeller is described in detail, and various models of the pumps are pictured. Aurora Pump Div., The New York Air Brake Co.

203 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, and cooling water treating is included in the illustrated bulletin. Milton Roy Co.

BOILERS, GENERATORS

204 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 t 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

205 Package Boilers — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room without extensive structural changes. Cyclotherm Div., National-U. S. Radiator Corp.

206 Steam Generators — Bulletin 55-1, 22-pp, describes company's products and services, including not only steam generators but also custom metal fabrication. There are many photos of boilers in various stages of assembly. Engineering drawings of boilers producing up to 500,000 lb of steam per hr on standard fuels are included, as well as illustrations of units for waste heat application and those designed to

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utilize refuse for fuels — wood chips, coffee grounds. The Wickes Boiler Co.

207 Packaged Steam Generator — Advantages of company's baffleless, pressurised two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

208 Steam Generators — Twelve-pp Bulletin PSG-2 contains design and construction details on company's package unit steam generator — a vertical, bent tube, longitudinally fired water tube boiler. Capacities, dimensions and weights are tabulated and drawings, diagrams and photos showing fabricating methods included. Henry Vogt Machine Co.

TUBING AND ACCESSORIES

209 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

210 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

211 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

212 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes. The Gustav Wiedeke Co.

213 Electric Tube Cleaners — Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and heat-exchangers. Tables are included giving complete specification details. Elliott Co.-Roto Plant, Div. of Carrier Corp.

LUBRICATION

215 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and avail-

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able in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

216 Lithium Greases — This product information bulletin presents manufacturer's six Litholine industrial greases, stressing industry advantages offered by these multi-purpose greases. Gives properties of the greases, general application and performance characteristics and includes test data. Sinclair Refining Co.

217 Lubricants — Specification, Classification — Vital information on selection of lubricants is presented in 10-pp Vol. 41, No. 4 of "Lubrication." Covers such items as performance specifications, initial suitability of lubricants, quality of lubricant, effect of lubricant on production, effect on maintenance, effect on power, effect on cost, and features a look to the future. The Texas Co.

COAL AND ASH HANDLING

219 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

220 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer.

221 Spreader Stoker — Advantages and features of company's continuous ash discharge spreader stoker are detailed in 24-pp Bulletin 40. Illustrates and describes operation details, and includes diagrammatically illustrated specifications, schematic diagrams showing installations with various types of boilers, and photos of typical installations. Detroit Stoker Co.

222 Why Stainless-Clad Steel — Advantages of stainless-clad steel for coal handling equipment are detailed in this 16-pp bulletin. Photo-stories of typical applications in hoppers, chutes, bunker noses, pipes and spreaders are included. Lukens Steel Co.

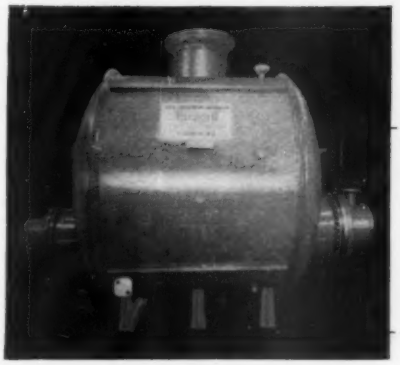
223 Jet Ignition Stoker — Information regarding company's jet ignition stoker is presented in Bulletin G-85. Rapid response to load change, ignition stability, efficient combustion, and a simple hydraulic drive are features described. Jet ignition stokers adapted to boilers in specific industries are shown and a typical fuel chart with comments and ASTM rank is also included. Babcock & Wilcox Co.

FUEL BURNING EQUIPMENT

224 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air

Paracoil

EVAPORATORS



Paracoil Makeup Feed Water Evaporator now serving the City of Columbia, Missouri power plant. Consulting Engineers, Lutz and May, Kansas City, Missouri. Rated at 6,000 lbs. of steam per hour at 30 psia, with carry-over not exceeding 1 PPM. Built to ASME code requirements.

creatively engineered by Davis for installation in numerous public and private power plants

Davis Engineered Features

- All tubes and rolled tube joints can be hydrostatically tested without removing tube bundle.
- Tube bundle, with outside packed floating head, has free movement to allow for expansion and contraction.
- Any tube can be replaced without disturbing adjacent tubes.
- No internal steam connection or blind gasketed joints.
- Removable tube bundle.
- Pitched tube bundle to provide for complete drainage of condensate.
- Tubes arranged on wide square pitch to facilitate mechanical cleaning.
- Straight tubes of equal length to simplify tube stocking.
- Single-pass tube bundle for maximum free flow area of steam in tubes and minimum pressure drop through tube bundle.

Paracoil Evaporator Installations include the following:

Puerto Rico Water Resources Authority
Consulting Engineers: Jackson & Moreland, Boston, Massachusetts

Borough of Wellington, Connecticut
Alabama Electric Cooperative, Inc., Andalusia, Alabama
Consulting Engineers: Burns & McDonnell, Kansas City, Missouri

Western Electric Cooperative, Inc., Andarko, Oklahoma
Consulting Engineers: Laramore & Douglass, Inc., Chicago, Illinois

City of Bryan, Texas
City of Lafayette, Louisiana
Consumer's Public Power District, Ogallala, Nebraska
Consulting Engineers: Lutz and May, Kansas City, Missouri

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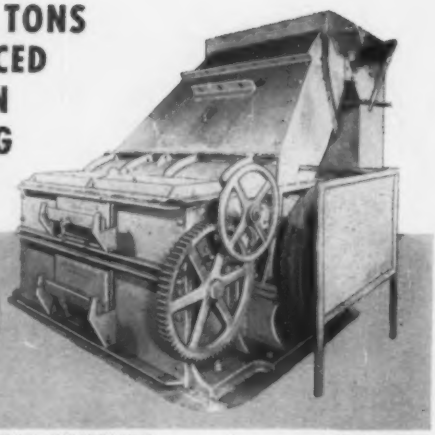

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Comments like this (from a midwest power plant engineer) are routine for American crushers. Custom built to your requirements, American crushers perform efficiently. They save power and maintenance by producing high tonnage at slow operating speeds.

Let American's engineers analyze your requirements and recommend the most efficient crusher for your operation. Write for literature; state your tonnage. No obligation.

When you figure costs — the best results come from American Rolling Ring Crushers.

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You can depend on WIEDEKE quality

PACKAGE BOILER
. . . and Stationary Fire Tube Boiler Tubes can be rolled and flared in one operation with this Modern Parallel Rolling Tube Expander.
See your Dealer or Write us for Bulletin 3400.
Guard holds Flare Roll back—desirable for rolling Tubes closely spaced in thin Tube Sheets.

THE GUSTAV WIEDEKE COMPANY
DAYTON 1, OHIO

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is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

225 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

226 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Coversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

REFRACTORIES, INSULATIONS

227 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

228 Refractory Cement — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

229 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Co.

230 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, fittings. Union Asbestos & Rubber Co.

WATER CONDITIONING

231 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine and properties and handling of the material. Olin Mathieson Chemical Corp.

232 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800 compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It dis-

cusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use two-bed, three-bed, four-bed, mixed or mono-bed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

233 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system are provided. Graver Water Conditioning Co.

234 Evaluating Steam Purity — Technical Paper 135, 88 pp, entitled "Conductivity vs Sodium by Flame Spectrophotometry. In Steam-Purity Studies," present results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

236 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW-7. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

237 Cooling System Treatment — Bulletin C1 describes advantages of company's treatment for cooling tower systems with synergised polyphosphates. Details of the system are fully covered. National Aluminate Corp.

238 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization of flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

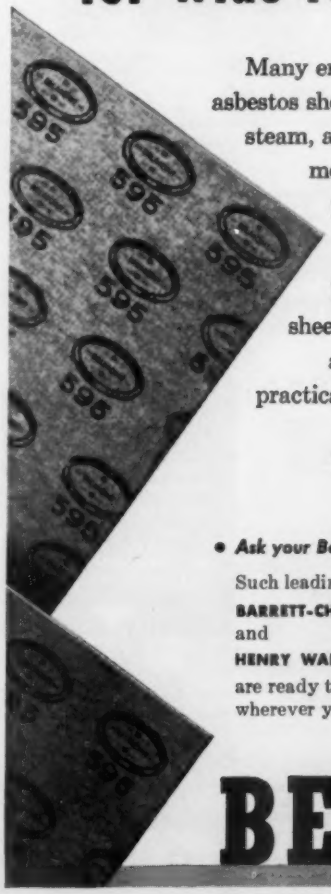
239 Corrosion Inhibitor — Bulletin 420-12-9 describes manufacturer's Composition TG, a sodium-zinc hexametaphosphate corrosion inhibitor for water systems, stressing its superiority in controlling corrosion in water mains and cooling equipment. Provides comparative graphs showing flow coefficients, rate of film formation as determined by weight loss and current flow, and schematic drawings of feeding methods. Calgon Co., Hagan Chemicals & Controls, Inc.

240 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

FANS, VENTILATING

241 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

VERSATILE sheet packing for wide range of service



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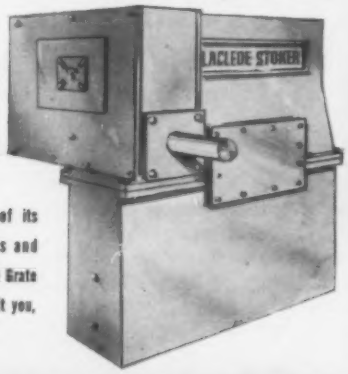

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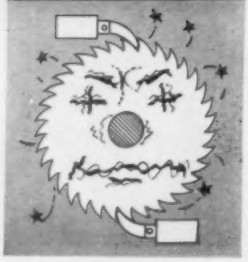

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242 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included. Buffalo Forge Co.

INSTRUMENTS, CONTROLS

243 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year, are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

244 Temperature Regulators — Six-pp Bulletin 1012 describes company's line of steam regulating valves with pilots for both fast and slow heating exchangers. Selection tables and line drawings of typical applications are also included. Spence Engineering Co., Inc.

245 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

246 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in., pressures from 30 in. vacuum or a few ounces up to 100,000 psi. Manning, Maxwell & Moore, Inc.

Postage-free cards for ordering catalogs are on page 119. You may also use the cards to order literature mentioned in the ads.

247 Auxiliary Alarm Facility — Bulletin C6 describes Eye-Hye remote reading gage with electrode and relay adaptation which actuates auxiliary audible or visible signals at high or low water levels. Reliance Gauge Column Co.

248 Station Controls — Described in 12-pp Bulletin 1032 are the control systems which help make more power for an outdoor Carolina steam-electric generating station. Text is illustrated with photos, schematic and block diagrams. Copes-Vulcan Div., Blaw-Knox Co.

249 Oil Leak Detection — Eight-pp illustrated Bulletin 80, on the Paraprobe oil leak detection system for steam-type fuel oil heaters gives a detailed explanation of the operation of the system. Provides installation diagrams, standard specifications, explains determination of condensate flow rate. Davis Engineering Corp.

250 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and oper-

ation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

ELECTRICAL EQUIPMENT

252 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kind of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses. Bussman Mfg. Div., McGraw-Edison Co.

253 Cable Troughs — This 28-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items. The Globe Co.

254 Electrical Enclosures — Bulletin EE, 14 pp, describes company's line of sheet metal electrical enclosures and other related items for a variety of applications. Covers control desks, electrical cabinets and enclosures, power distribution and control panels, boiler, turbine generator control panels, switchgear housings, and others. The Kirk & Blum Mfg. Co.

MECHANICAL POWER TRANSMISSION

257 Sprockets, Couplings — Bulletin A-644B, 32-pp, contains full description, including engineering drawings, installation photographs, prices, selection data and advantages of this company's line of roller chain sprockets, chain, and chain couplings. All feature Taper-Lock bushings for mounting easily and securely on shafts. Dodge Mfg. Corp.

258 Self-Aligning Couplings — Featured in this illustrated bulletin are company's self-aligning forged steel couplings designed to transmit maximum torque indefinitely. A cutaway view showing component features included. Koppers Co., Inc.

FUEL CONDITIONING

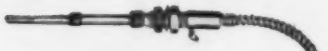
259 Better Fuel Performance — This bulletin describes two of company's products designed for better fuel performance and economy. The first is a fuel oil sludge dispersant which prevents sludge and moisture separation in heavy fuel oil. The other is a soot remover. Western Chemical Co.

260 Fuel Oil Conditioner — A fuel oil conditioner which dissolves all sludges, prevents new sludge from forming, excels as an emulsifier of condensation, holds water, sludge and oil in complete suspension and exhibits other performance advantages is described in a recent published pamphlet. Kor Corp, Div. Oxi Corp.

VALVES, TRAPS AND PIPING

261 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y

Which of these characteristics are essentials on your Remote Control Jobs?



• Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of ACCO TRU-LAY PUSH-PULL *flexible* CONTROLS that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our DATA FILE available for your further study.

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VERSATILITY of this fine remote control can best be illustrated by citing some of the jobs it handles well . . . HOT jobs on jets and industrial furnaces . . . COLD jobs down to —70°F . . . WET jobs (the conduit can be completely immersed) . . . DIRTY jobs . . . ABRASIVE jobs . . . CORROSIVE jobs . . . HEAVY, TOUGH jobs up to 1,000 lbs. input . . . LIGHT DUTY jobs . . . REMOTE jobs 150 feet or more from the control point. These units are frequently and successfully used in conjunction with electric, hydraulic and air controls . . . are thoroughly effective under almost any operating condition.

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Advantages of Tru-Lay Push-Pull flexibility and simplicity are pictured below

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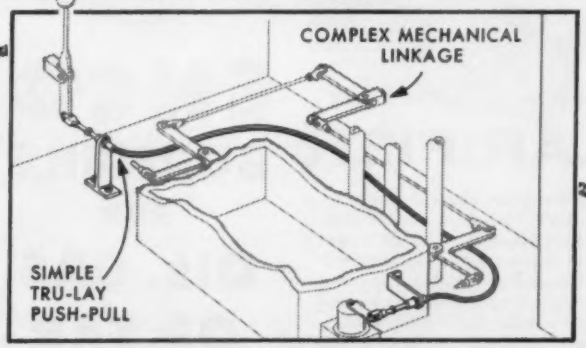

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased back-lash, lost accuracy and vibration rattles.

• Whether your interest is in a single application of this versatile PUSH-PULL CONTROL, or in its inclusion as a component of the product you manufacture, the six booklets and bulletins in this DATA FILE will answer your further questions, and will also provide you with the means of defining to us the applications you may be interested in.

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valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

262 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

263 For High Pressures, Temperatures — Bulletin B-453, 12 pp, describes company's high temperature and high pressure valves for service in steam power plants and related installations. Cutaway views illustrating design and construction features are included, as well as temperature-pressure ratings table, selection chart, dimensions, weights. Yarnall-Waring Co.

264 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up. The Henry Pratt Co.

266 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics covered. Crane Co.

267 Industrial Valves—Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

268 Water Hammer Control—Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

269 Industrial Expansion Joints — Advantages of company's line of industrial expansion joints designed for rugged temperature and pressure extremes are detailed in this illustrated brochure. Typical applications are pictured. Solar Aircraft Co.

270 Steam Trap — Bulletin 257-B describes a steam trap which uses the kinetic energy of steam to close the valve. Features of trap are detailed, and dimensional data included. Sarco Co., Inc.

271 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes

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de-alkalize
clarify
WATER

REMOVE
organic matter
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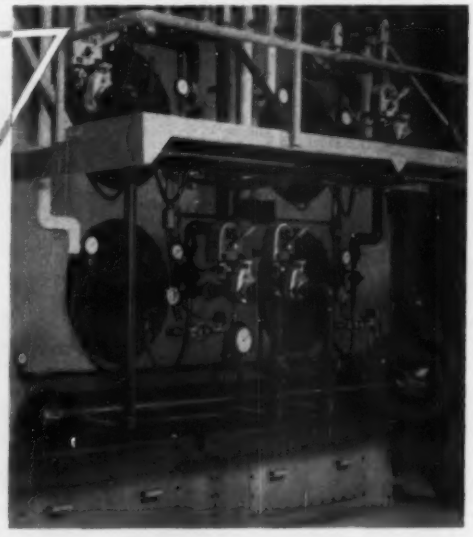

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of equipment; and a maintenance section. Armstrong Machine Works.

272 Steam Traps — Quick-Flex thermostatic steam traps for outdoor and non-freeze service are described in Bulletin 257. Itemizes typical uses for these traps. Specifications and capacities are given in tabular form, accompanied by dimensional drawings. Diagram shows recommended installation. The V. D. Anderson Co.

273 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

274 Flexible Hose, Bellows — Sixteen-pp Catalog 156 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Flexonics Corp.

OTHER EQUIPMENT

275 Mechanical Packings—Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered. The Belmont Packing & Rubber Co.

278 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

279 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

280 Precipitation Products—Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

281 Pipe Insulation — Featured in brochure J-432 is a lightweight, flexible, one-piece pipe insulation composed of incombustible, moisture-resistant mineral wool fibers, bonded with a phenolic resin and molded into 6-ft long sections. Characteristics of the material are described and a table of recommended thicknesses included. Baldwin-Hill Co.

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Here again on a major American building protection against water hammer is assured by Williams-Hager Silent Check Valves. The valves operate instantly when flow reversal starts or when flow is zero.

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No. 851 on Cause, Effect and Control of Water Hammer

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282 Product Guide—This illustrated 8-pp bulletin contains descriptive information on company's industrial products division and the products it manufactures, including power plant equipment, bridges, pressure vessels, process industry equipment and a wide variety of specialized products. Describes manufacturing facilities and includes production photos of manufacturing processes. Industrial Products Div., Maryland Shipbuilding & Drydock Co.

283 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plants utilizing these fabrications. They cover a wide range of industries, including paper, petroleum, steel, as well as utilities. Connery Construction Co.

284 Insulated Stack — This illustrated folder on company's pre-cast insulated stack contains complete product information, including advantages and description, specifications, suggested installation methods. Van-Packer Corp.

285 Process Equipment — Bulletin G-3B describes equipment for process industries, including pneumatic conveying systems, compressors and vacuum pumps, coolers and preheaters, blowers, gas and vacuum pumps, fans and gas washers, accessories. In addition to describing features and advantages of the equipment, bulletin includes engineering data tables, photos and drawings. Fuller Co.

286 Aluminum Jacketing — Bulletin 530a describes company's line of aluminum weather-proof jacketing for insulated lines, towers, vessels and tanks. Application procedures are pictured and suggested specifications offered. Childers Mfg. Co.

287 Electric Heating Units — Catalog 50, 50 pp, contains complete engineering data on electrical heating units and equipment, including strip elements, finstrip elements, tubular elements, cartridge elements, ring elements, immersion heaters, circulation heaters, radiant heaters, forced air duct heaters, unit heaters, hot plates and others. Includes photos, dimensional drawings, prices, standard rating tables. Edwin L. Wiegand Co.

288 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance, techniques and skill in manufacture of equipment. Describes rubber and plastic pipe, tubing and fittings; valves; pumps; lined tanks. Amerace Corp, American Hard Rubber Co.

289 Valveless Filter — Operation of company's automatic valveless filter is described in this 8-pp illustrated bulletin. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

290 Is Salt Just Salt? — This is the title of an 8-pp bulletin describing salt characteristics and properties as well as geographical distribution. Variations in salt from different areas in the United States are illustrated and company's refined salt products and applications are described. Morton Salt Co.

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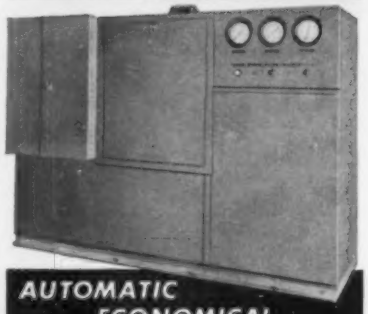

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● Fully Automatic ● Low Fire Start ● Electric-gas Ignition ● Modulating Fire Control ● Damper Sequence Control ● Forced Draft Combustion Air ● Electronic Combustion Safety Supervision ● Mechanical Atomizing—Steam assisted internal mixing oil burner ● Ring or Cylindrical type Gas Burner for gas fuel ● Fire tested before shipment.

NOW . . . with the new Series 20 Packaged Firing Unit you can have all the advantages of the outstanding Dual Stage burner in a completely packaged unit equipped with the latest in electronic safety controls to give *automatic* start, *automatic* modulation, *automatic* shutdown.

Series 20 Packaged Firing Units are factory fire tested, ready for immediate and low cost installation in your furnace room. They need only oil, gas, steam, draft and electrical connections—everything else needed for fully automatic burner operation is there.

Capacities of standard units range from 200 to 830 boiler horsepower. (7,200 to 30,000 pounds of steam per hour). Larger units are available on order to meet your special needs.

Units may be used with any standard boiler or furnace under natural or induced draft, or with pressurized boilers —in which case the unit provides sufficient forced draft to overcome draft loss through boiler. Where a high chimney or induced draft fan is used, an automatic damper motor is furnished to provide a constant furnace draft during operations; and a reduced or zero draft during shutdowns.

Preventative Maintenance consists chiefly of keeping the burner gun clean, with periodic inspection and cleaning of strainers and safety devices. This minimum maintenance will give your engineer or fireman extra time to attend to blow-down, soot-blowing, or to check operations and efficiency of plant and auxiliary equipment.

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NEW ENGINEERING BOOKS

Engineering Vibrations: With Applications to Structures and Machinery, by Lydik S. Jacobsen and Robert S. Ayre. 564 pages, 6 by 9 in., paper. Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York 36, N. Y. Price $10.00.

Written on a deliberately chosen intellectual level aimed at the senior or early graduate student in American engineering schools, the book seeks to enable the practical engineer to deal effectively with linear and non-linear vibration problems by simple methods. It has developed a treatment of these problems that can be followed with comparative intellectual ease by the student possessing some knowledge of differential equations, and is presented in such a way that it is possible to use the book for unsupervised study.

The selection of topics and problems has evidently been dictated by the author's familiarity with practical vibration studies and with engineering students, which, in the case of the senior author, spans a period of more than twenty-five years.

★ ★ ★

High Speed Diesel Engines, by Arthur W. Judge. Fifth Edition, 1958. 578 pages, size 6 by 9 in., cloth. Published by D. Van Nostrand Co, 120 Alexander St, Princeton, N. J. Price $12.00.

Because of its comprehensiveness and authority, this book in its previous editions has become regarded by many as the foremost in its field. Present edition has been altered and expanded, adding such chapters as Air-Cooled Engines, Special Purpose Engines and The Starting of Engines. As an example of its scope, the book contains a rather detailed discussion of coal-burning compression-ignition engines, their virtues and faults.

Text is written in straightforward, precise language, achieving unusual clarity and readability. Illustrations are good, abundant, and helpful.

★ ★ ★

Centrifugal and Axial Flow Pumps, by A. J. Stepanoff. Second Edition, 1958. 462 pages, size 6 by 9 in., cloth. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price $12.00.

An orderly, logical approach to all aspects of the subject, this book is on the professional level, for those who design these pumps or the systems in which they are used. Except that it serves well to acquaint the engineer in the plant with the problems confronting the designer of pumps and systems, and in some cases to help him to diagnose difficulties which he may be having, it is of somewhat limited value to the average power engineer.

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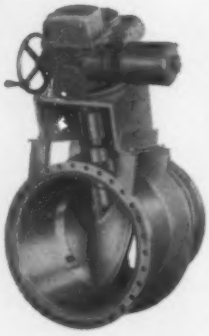

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However, to one who wants a complete exposure to pump design, application and operation, this material is excellent. This edition is revised and expanded to include the wealth of information which has been developed since the first edition in 1948. This includes a new chapter on Water-Hammer Problems in Centrifugal Pump Systems, and new material on centrifugal-jet systems, thermal cavitation criterion, viscosities, characteristics of axial and mixed-flow pumps, and numerous design refinements.

That the author, who has been with the Ingersoll-Rand Co since 1940, before which he spent 11 years with Byron-Jackson, knows every detail of this complex subject, and is able to present with great clarity, is readily discernible to the reader of the volume. Respect for both Mr. Stepanoff and the field is generated when one either reads the entire book or refers to the material on the particular subject in which he is interested.

* * *

Management for Engineers, by Roger C. Heimer. First Edition, 1958. 453 pages, size 6 by 9 in., cloth. Published by McGraw-Hill Book Co, 330 W42nd St, New York 36, N. Y. Price $6.75.

This book fills a definite need. Any engineer, from the young graduate to the executive, will find his time reading it well spent. It will serve to point out his relation to the well-being of his company in many ways he may not have previously realized.

Using a mythical business firm, the author brings forth repeatedly the influence that the engineer can and should have on the over-all picture of his company's health — and net income. The firm selected, the Z. A. Zalk Equipment Co, is of such size and function that it succeeds in demonstrating the author's purpose in all cases.

Added value in the book is found in the fact that it may be read completely through, or read, and used, chapter by chapter. Business organization, money flow, production costs, interest and time, insurance, depreciation, inventory, budgets, and many other subjects, through management decisions and industry decision-making situations are covered.

* * *

Induction Motors, Single-Phase and Polyphase, by Charles S. Siskind. First Edition, 1958. 400 pages, size 6 by 9 in., cloth. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y. Price $7.50.

While the squirrel-cage induction motor is undoubtedly used for industrial service in greater numbers than any other type of machine, the versatility of the motor in too many cases is not realized, specified, or appreciated. The rotor contains no insulated winding or commutator, is therefore not subject to the problems of commutation, and is virtually a solid mass of magnetic and electrical material that is practically indestructible. Extensive research and design have

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so well perfected the motor that it is capable of developing operating characteristics suitable to an extremely wide range of applications. Purpose of this book is to expose every power engineer to the possibilities of using a specified induction motor for a particular purpose. In this sense it is invaluable to his library.

Approach to the subject is practical, including word pictures, neat sketches, and good photographs. Mathematical analyses are used only where necessary to clarify. Motor controls are covered rather completely. Each chapter is summarized, correlating important topics.

★ ★ ★

Better Report Writing, by Willis H. Waldo. 231 pages, 5 by 7⅜ in., cloth. Published by Reinhold Publishing Corp, 430 Park Ave, New York 22, N. Y., 1957. Price $4.75.

Written to be of ready help to technical report writers, this handy desk guide presents authoritative facts on effective scientific composition, style, division of reports, tables, illustrations, and use of words. Three appendices cover abbreviations, symbols and hyphenation.

Willis Waldo has been working with the problems of technical writing for many years. After joining Monsanto Chemical Co as a technical editor, he wrote Guide to Report Writing, a manual for laboratory personnel. He holds a B.S. and M.S. in inorganic chemistry.

★ ★ ★

Human Understanding in Industry, by Dr. William C. Menninger and Dr. Harry Levinson. First Edition. 112 pages, 5½ by 8 in., paper bound. Published by Science Research Associates, 57 W Grand Ave, Chicago 10, Ill. Price $2.25.

This is a down-to-earth aid for supervisors — it takes up the cases of real people, and gets to the heart of the problems of people who really exist. Typical personalities include the quiet, efficient, but withdrawn worker, the excuse maker, the accident prone, the complainer, the buck passer. Every supervisor will have some or all of these personalities to work with, and this book helps him see his way to work *with* them, rather than *against* them. This conserves our greatest resource, manpower.

This book is distinguished in that it does not give pat answers. It exposes a type, describes the influences that may have contributed to the situation, and gives the supervisor the understanding necessary to deal with the individual most advantageously.

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Throughout these pages are numerous case histories ***continued on page 133***

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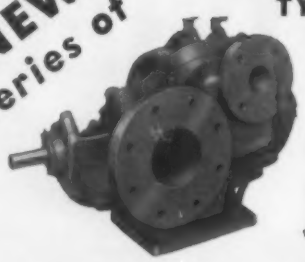

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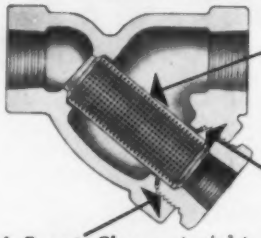

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The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 119–120.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address—and mail the card.

You may also use the Reader Service Cards to request information on products described, or literature mentioned in the ads—just circle the number below the ad.

Engineering Books

continued from page 131

drawn from the authors' long experience in the field. These serve to identify to the studying supervisor the exact nature of the problems involved, and help him relate these problems to his own employees.

An excellent addition to the book is the pamphlet designed to be used when presenting the material to a group of supervisors. When the helpful suggestions contained in this Leader's Guide are employed, delivery of the course can be greatly expedited and improved.

★ ★ ★

Filler Metal Comparison Charts. First Edition, 24 pages, 8½ by 11 in., paper bound. Published by the American Welding Society, 33 W 39th St, New York 18, N. Y. Price $2.00.

To anyone who is concerned with welding, or the purchase of welding materials, the information in this book should be of the greatest assistance. All of the brand names of the welding rods and electrodes of 61 manufacturers are classified in accordance with 12 AWS-ASTM specifications. They are arranged in convenient charts so that comparisons may readily be made.

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Complete descriptive literature and samples are available at either of the above mentioned plants upon request.

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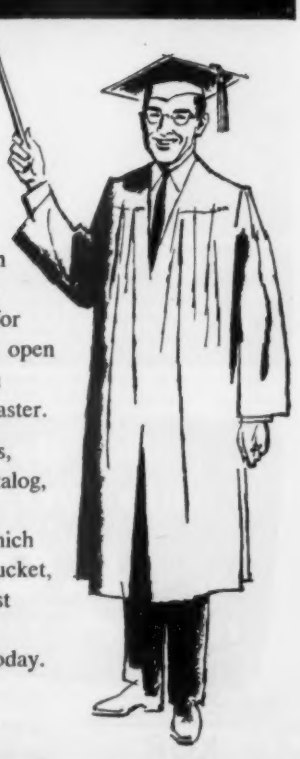
For other sound design recommendations, send for Anderson's new engineering catalog, "How to Select SteamTraps and Fluid Specialties." This valuable booklet tells which of the four basic types of traps—inverted bucket, thermostatic, combination or float—is best for any installation. Send for your complimentary copy. Mail the coupon today.



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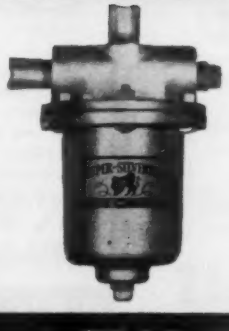

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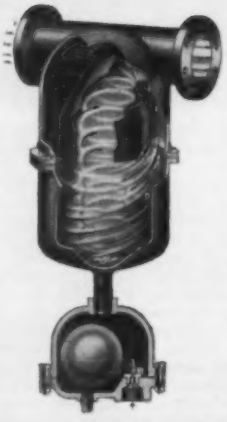

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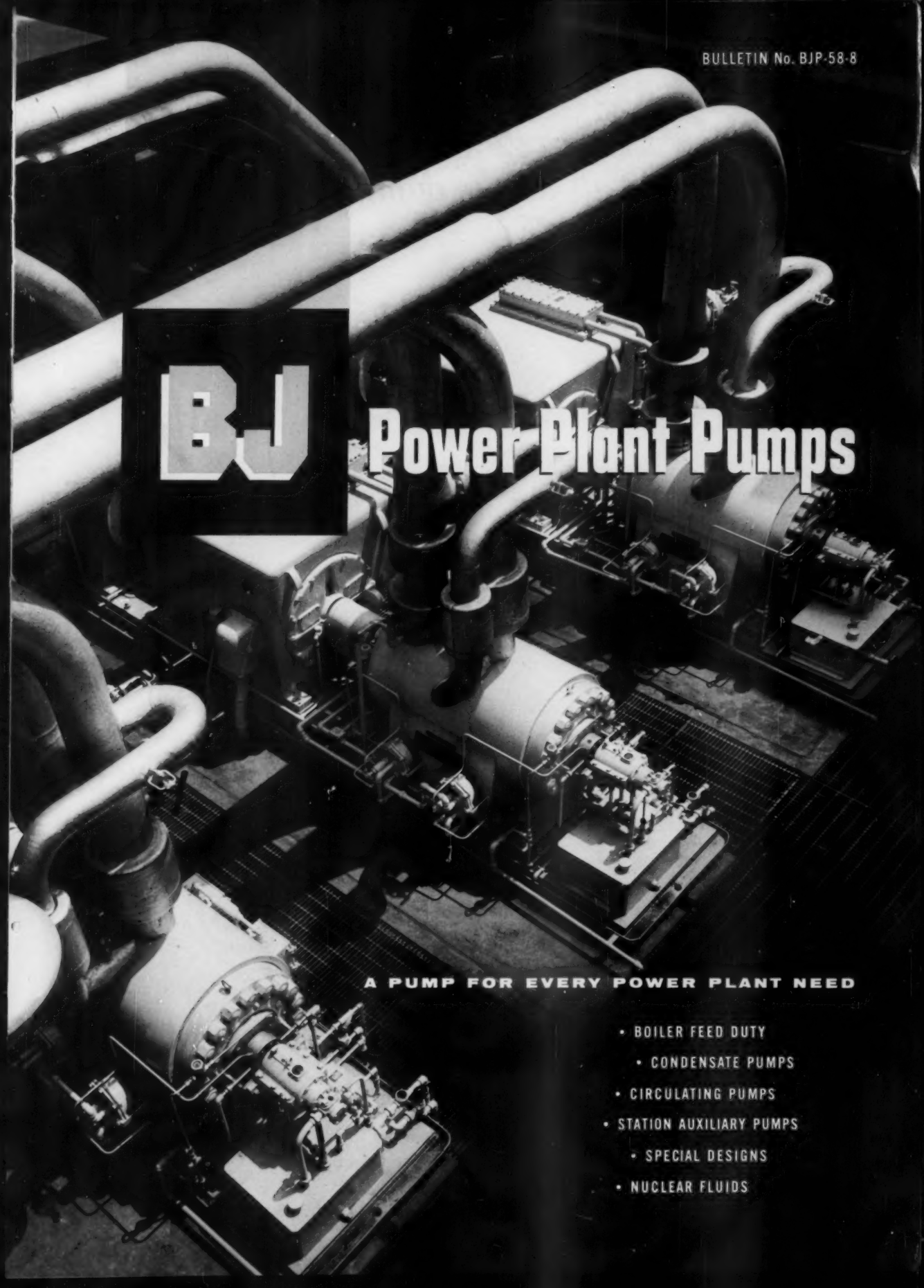

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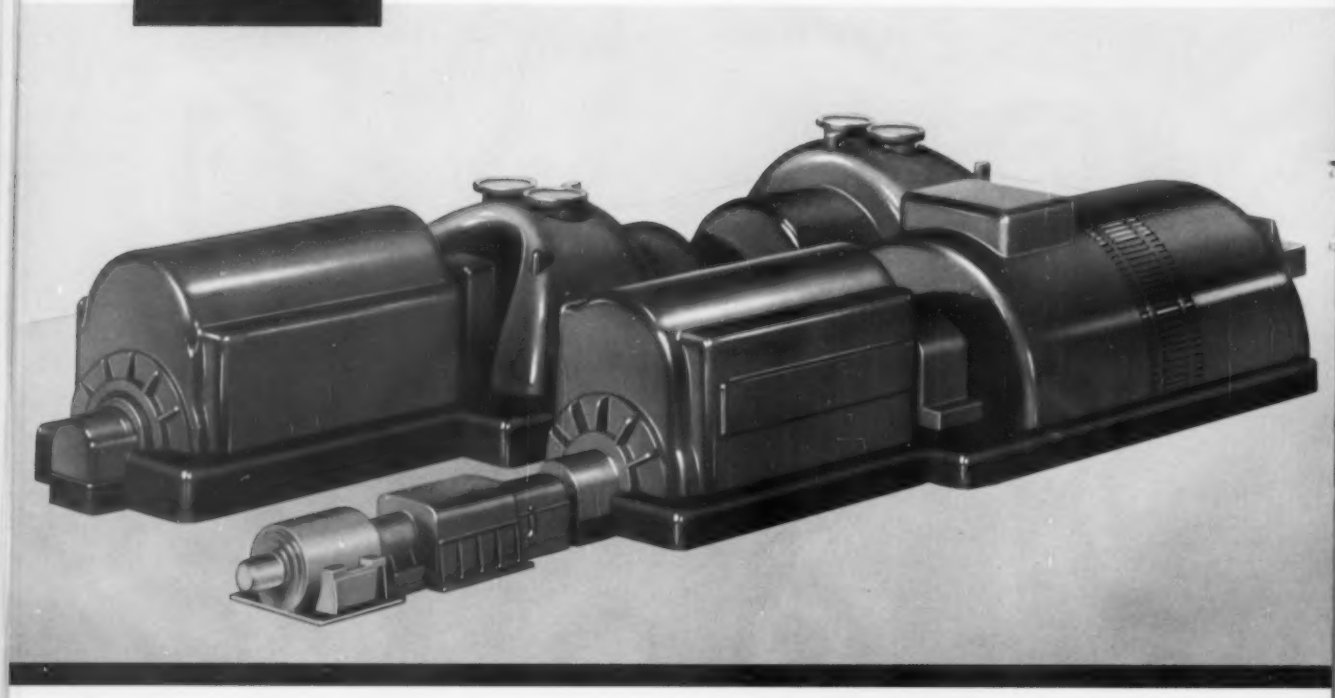
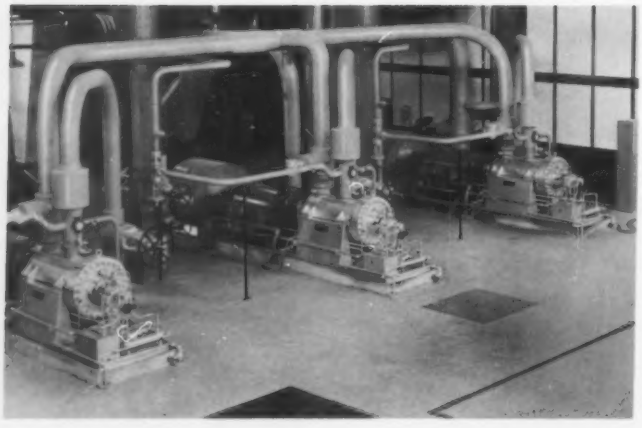


12,000 hp, 3600 rpm Double-Case Boiler Feed Pump

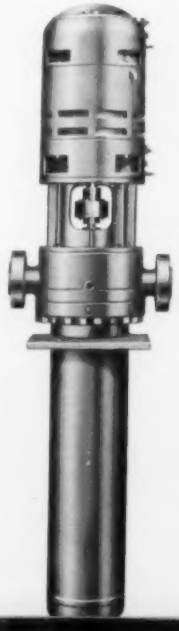
Typical of the advanced engineering and design of Byron Jackson pumps is this unusual double-case, high-pressure boiler feed pump. Through a unique arrangement the pump is directly driven from the main generator shaft. It will deliver feed water at 6330 gpm against a 6400 foot total dynamic head.



DOUBLE CASE BOILER FEED PUMP – Reliability, simplicity and ease of maintenance have been emphasized in this BJ design. The result is a highly efficient pump in which complete confidence can be placed. Sizes and capacities are available as required.

VERTICAL DOUBLE CASE PUMP

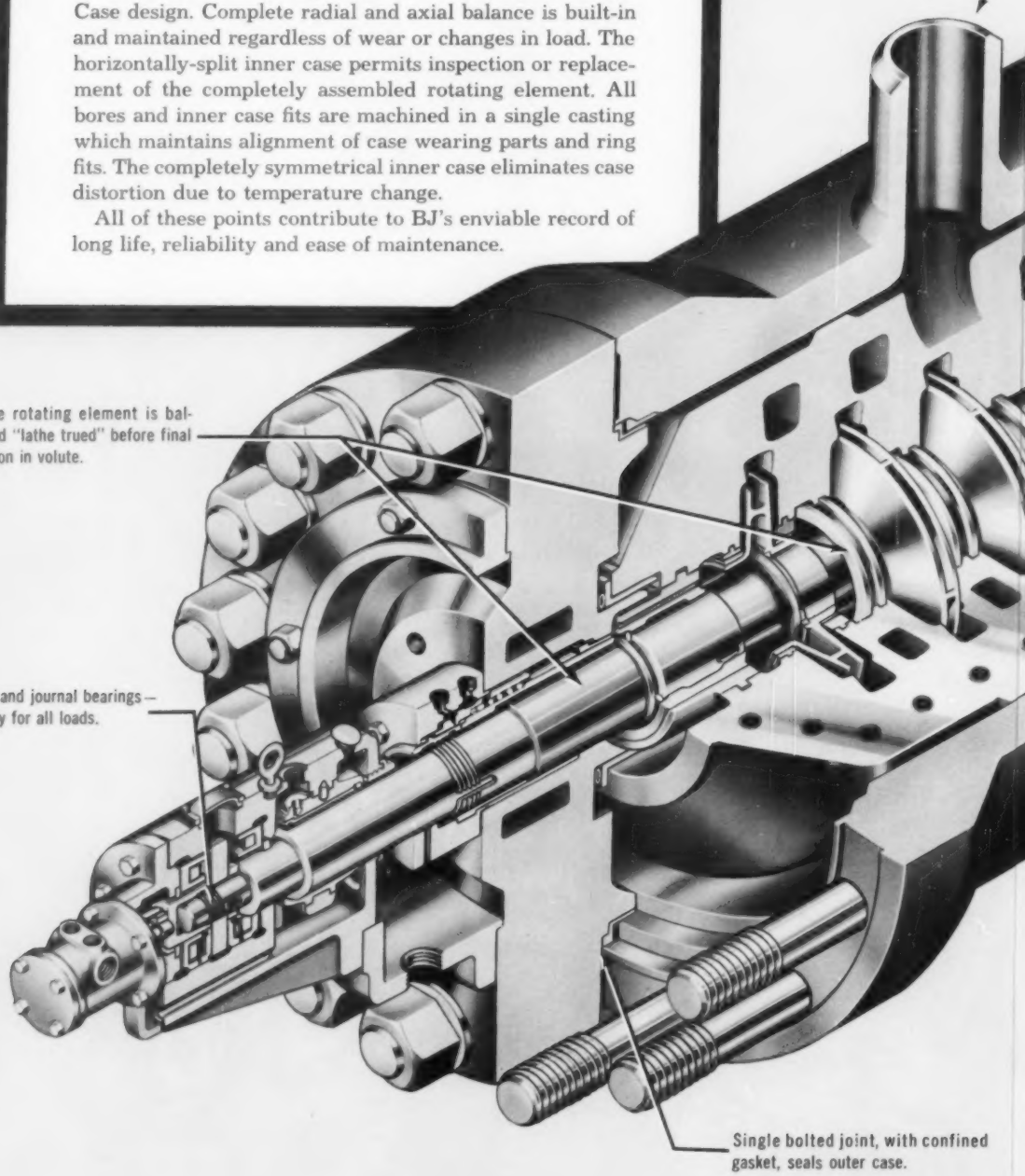
The advantages of the double-case design are featured in this compact, vertical pump. For high-pressure, high-speed with low capacity, or operated in series of two or more for higher performance. Capacities are from 20 to 500 gpm with heads from 50 to 500 feet per stage (to 5000 psi).



the **BJ** Double-Case Boiler Feed design

Several distinct advantages are inherent in the BJ Double Case design. Complete radial and axial balance is built-in and maintained regardless of wear or changes in load. The horizontally-split inner case permits inspection or replacement of the completely assembled rotating element. All bores and inner case fits are machined in a single casting which maintains alignment of case wearing parts and ring fits. The completely symmetrical inner case eliminates case distortion due to temperature change.

All of these points contribute to BJ's enviable record of long life, reliability and ease of maintenance.


Suction and discharge nozzles are available to customer's specifications.
Complete rotating element is balanced and "lathe trued" before final installation in volute.
Sturdy thrust and journal bearings — ample capacity for all loads.
Single bolted joint, with confined gasket, seals outer case.

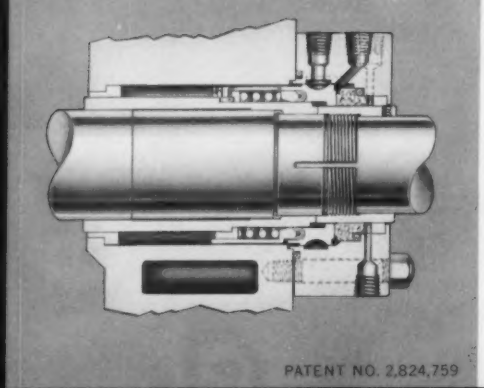
Double suction first stage impeller permits operation at minimum NPSH.

Water-jacketed BJ Mechanical Seals save treated feed water and BTU's usually lost through gland leakage—eliminate packing maintenance and shaft sleeve replacement.

Horizontally-split inner volute permits inspection, removal, or replacement of rotating element as an assembled unit. All fits available for quick inspection.

Volute design accommodates uniform temperature expansion encountered in emergency start up.

Impellers mounted in equally opposed groups for hydraulic axial balance. Double volute assures radial balance.

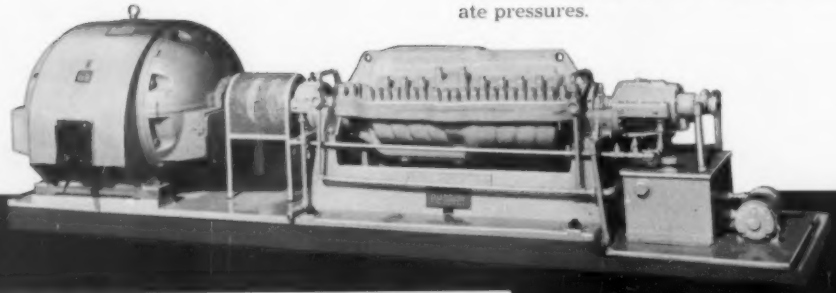


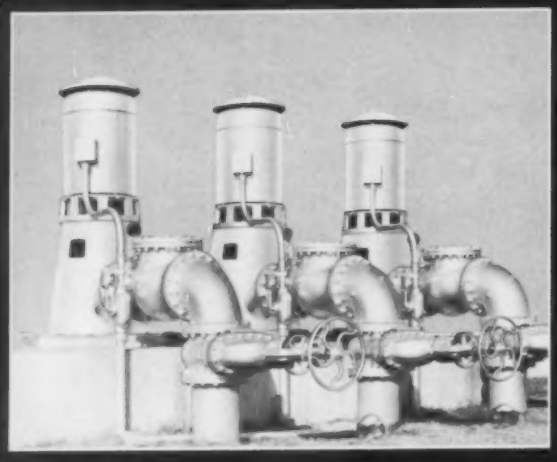
PATENT NO. 2,824,759

BJ MECHANICAL SEALS FOR POWER PLANT SERVICE

Especially designed for sealing against the high pressures and temperatures of power plant service, BJ Mechanical Seals are recommended for all pumps. On the type D Seal shown here, the rotating face incorporates a pumping ring for circulating cooled liquid to the seal faces. In addition, water jacketing is provided to prevent temperature damage while unit is on standby.

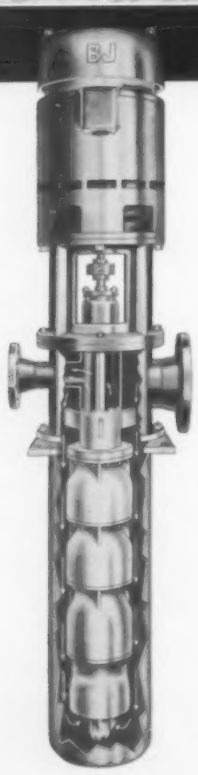
DVMX PUMPS—A proven, split-case boiler feed pump with double row bolting to prevent interstage leakage or bowing at parting flanges. Compact, symmetrical design allows safe operation to 500° F. . . hydraulic pressures to 4000 psi . . . metallurgy and construction permits speeds to 7000 rpm. Easily adapted for interstage take-off at intermediate pressures.





VERTICAL CIRCULATING PUMPS

For continuous operation at high efficiencies, these standard circulating pumps draw from a sump and require little floor space. Available in single or multi-stage units with a wide choice of discharge column and mounting arrangements. Capacities are to 24,000 gpm with heads to 500 feet, and up to 45,000 gpm with heads of 250 feet or less.

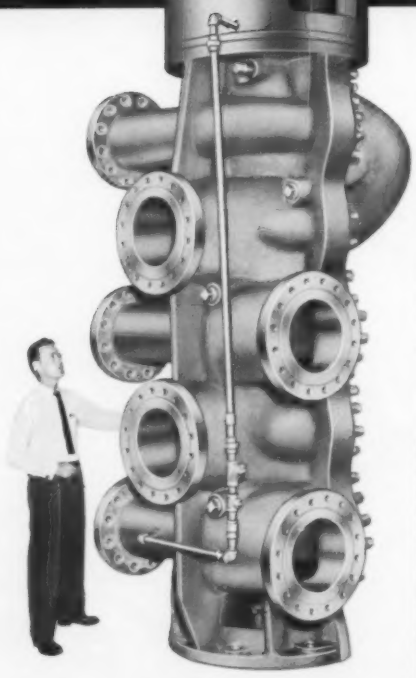


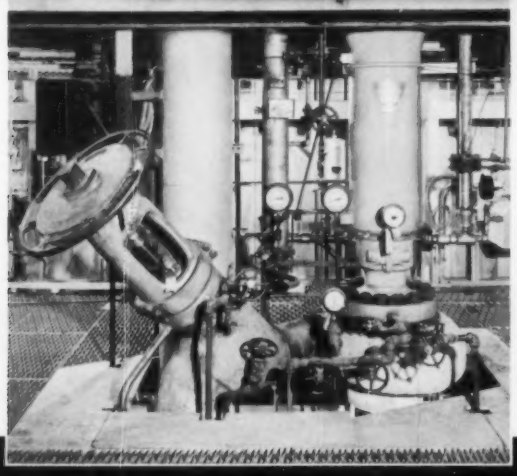
VERTICAL CONDENSATE PUMPS

Ideal for pumping liquids near the boiling point, or for any application where NPSH is limited. This multi-stage, vertical pump is a self-contained unit mounted in a barrel which creates its own suction sump. Requires minimum floor space. Standard models have capacities up to 2000 gpm with heads as required.

SPECIAL POWER PUMP DESIGNS

Always first in the development of improved designs and greater pump efficiency, Byron Jackson can engineer and build special pumps for any requirements. Shown here is a 4 in 1 condensate pump which uses one driver for four pumps. This common shaft arrangement saves floor space and provides added reliability with only one stuffingbox necessary.

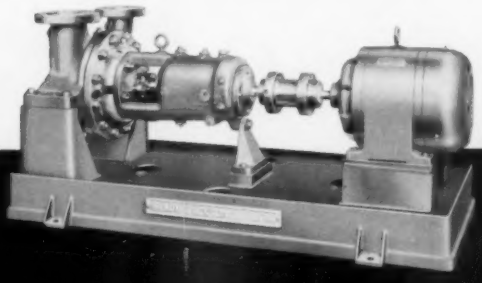




BOILER RECIRCULATING PUMP—The BJ Electro-mersible, shown here, operates under full boiler pressures and temperatures to provide efficient circulation for peak boiler performance. Vertical design with a heat barrier and wet-winding motor eliminates the use of a stuffingbox. Suction pressures 2000 psig and above, water temperatures to 658° F. Capacity is 6970 gpm with a 124 foot head and up to 10,000 gpm at reduced head pressures.

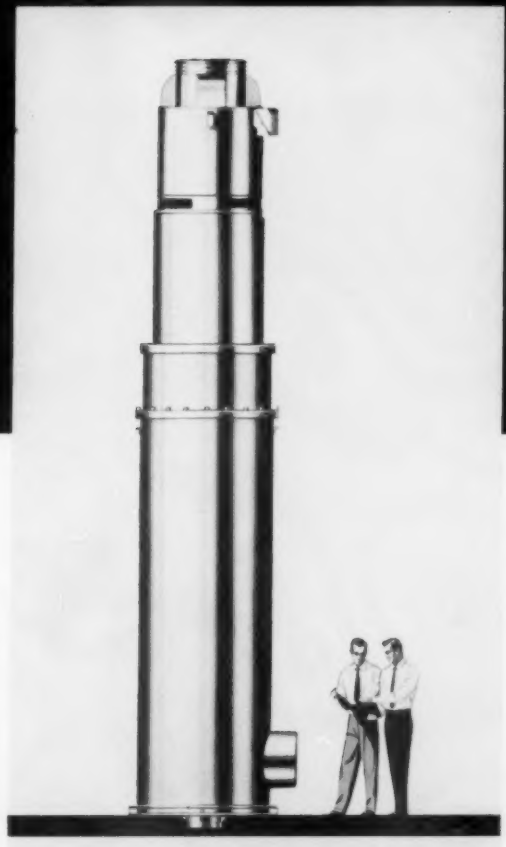
SM PUMPS

A heavy-duty process type pump for use in condensate and light boiler recirculation duty. Easily dismantled for inspection without disturbing major piping. Single and double stage models available for a wide range of pressures and at temperatures to 800° F. Capacities are to 3800 gpm, heads to 1600 feet.



HIGH SPEED RECIRCULATING PUMPS

This combination feed and booster pump is an example of BJs advanced leadership in pump engineering. Weight, space and NPSH were all critical design factors in this pump which operates at 15,800 rpm.



Whatever your pump requirements for power plant service, Byron Jackson can furnish the best equipment for the job, and is backed by over 86 years experience in design and manufacture of quality pumps. Detailed performance and specification information is available on the pumps shown here from your nearest BJ office.

Since BJ *1872*

BYRON JACKSON PUMPS

INCORPORATED

A Subsidiary of Borg-Warner Corporation

BOX 2017A, TERMINAL ANNEX • LOS ANGELES 54, CALIFORNIA

BJ PUMPS FOR NUCLEAR POWER APPLICATIONS

This giant BJ Liquid Sodium Pump is used for primary cooling in a nuclear fueled power plant. Standing 35 feet and with a 6 foot diameter, it is rated at 1,000 hp and delivers liquid sodium at 1000°F, at 11,800 gpm with a 310 foot head! BJ designs and manufactures all types and sizes of pumps and mechanical seals for nuclear fluids.

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The new, patented Maxivision dial on American Bi-Metal Thermometers eliminates the perspective effect of usual pointer-above-dial construction. No parallax! Readings are sure, sharp and accurate – exact working temperatures are always right before your eyes. It is a two-level dial. A raised outer ring, set close to the cover glass, carries the graduations. The index type pointer is on the same plane as the outer ring, with the numerals on a lower level.

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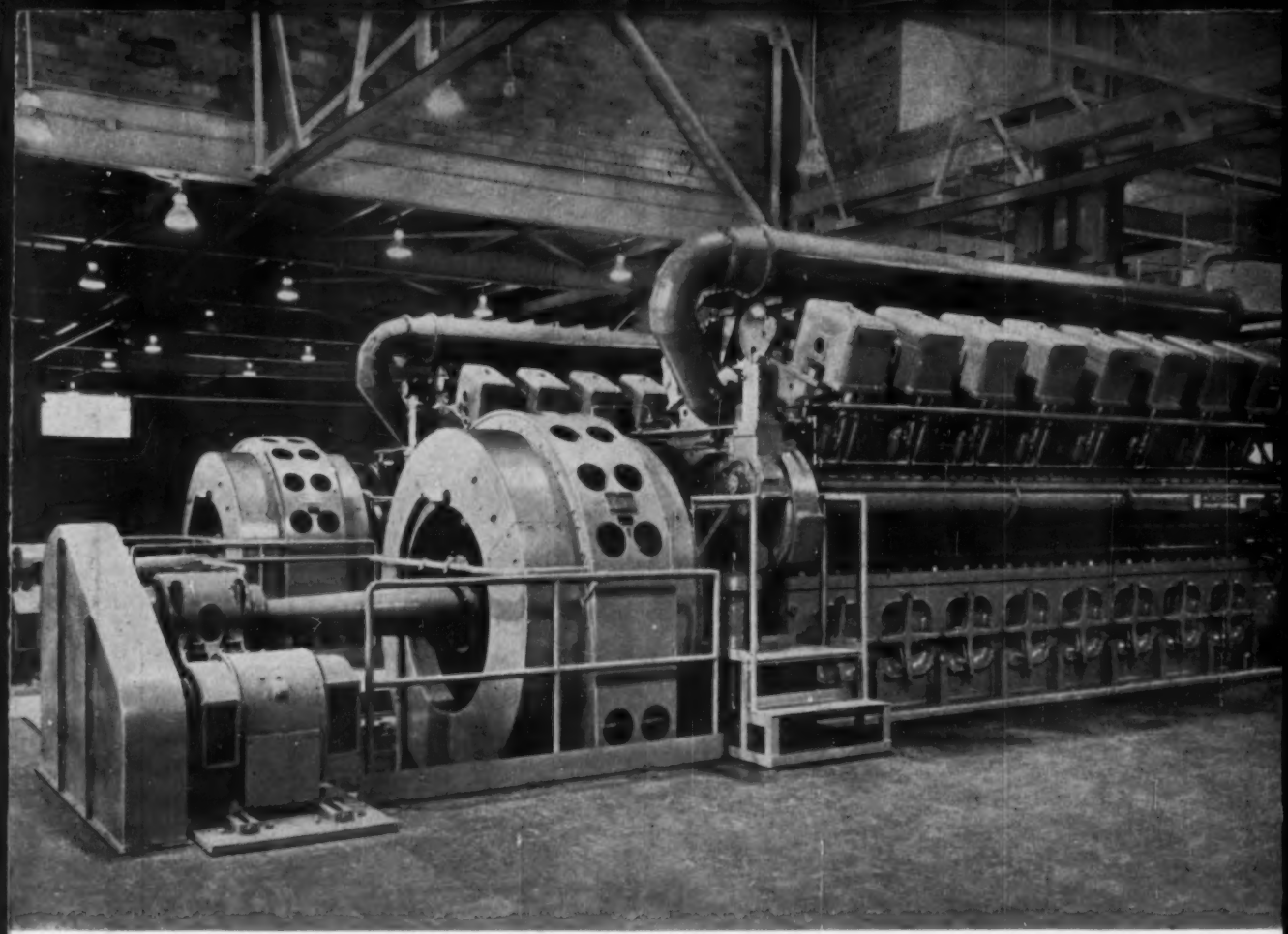

Texaco Ursa Oil lubricates each of these V-type 16-cylinder diesels which supply standby power in Narragansett Electric Co.'s Westerly, R. I., plant.

Bore and stroke of each engine is 13 x 16½"; each is rated at 3,500 hp at 514 rpm. Each generator has a net rating of 2,500 kw.

Texaco Ursa Oil protects Narragansett's reserve power

Narragansett Electric Company uses these two Supairthermal V-16 diesels for standby power. It's essential that these engines be instantly available, even after long periods of idleness. That's why Narragansett uses Texaco Ursa Oil to protect engine power, keep it reliable and ready—anytime.

With Texaco Ursa Oil in the crankcases, Narragansett engineers are certain of getting full rated horsepower because Texaco Ursa Oil keeps rings free and prevents the formation of harmful deposits. And because Texaco Ursa Oil is a premium quality lubricant, it protects against wear, minimizes operating and maintenance costs.

There is a complete line of Texaco Ursa Oils refined and processed especially for the lubrication of diesel, gas and dual-fuel engines. In fact, *for over twenty-years, more stationary diesel horsepower in the United States has been lubricated with Texaco than with any other brand.*

Your Texaco Lubrication Engineer offers his years of experience to help you select the right Texaco lubricant for your needs. You can contact him by calling the nearest of the more than 2,000 Texaco Distributing Plants, or by writing: The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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